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INTERREGIONAL HIGHWAYS

MESSAGE

FROM

THE PRESIDENT OF THE UNITED STATES

TRANSMITTING

A REPORT OF THE NATIONAL INTERREGIONAL HIGHWAY COMMITTEE, OUTLINING AND RECOMMENDING A NATIONAL SYSTEM OF INTERREGIONAL HIGHWAYS

JANUARY 12, 1944.—Referred to the Committee on Roads and ordered to be printed with illustrations

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MESSAGE FROM THE PRESIDENT

To the Congress of the United States:

On April 14, 1941, I appointed a committee, known as the National Interregional Highway Committee, to investigate the need for a limited system of national highways to improve the facilities now available for interregional transportation, and to advise the Federal Works Administrator as to the desirable character of such improvement, and the possibility of utilizing some of the manpower and industrial capacity expected to be available at the end of the war.

The committee, with the aid of a staff provided by the Public Roads Administration, made careful and extended studies of the subject, and has submitted to me its final report which I transmit herewith and commend to the favorable consideration of the Congress. The report recommends the designation and improvement to high standards of a national system of rural and urban highways totaling approximately 34,000 miles and interconnecting the principal geographic regions of the country.

The recommended system follows in general the routes of existing Federal-aid highways, and when fully improved will meet to optimum degree the needs of interregional and intercity highway transportation. Its development also will establish a transcontinental network of modern roads essential to the future economic welfare and defense of the Nation.

While the annual rate of expenditure to accomplish the improvement of the rural and urban sections of the system over a reasonable period of years will be dependent upon the availability of manpower and materials, and upon other factors, the required expenditure is estimated at $750,000,000 annually. The over-all expenditures would be approximately equally divided between urban and rural sections of the system.

The improvement of a limited mileage of the most heavily traveled highways obviously represents a major segment of the road replacement and modernization program which will confront the Nation in post-war years, in rural and urban communities alike. The committee found that the national network outlined in its report comprises only 1 percent of the total road mileage of the United States but carries 20 percent of the total travel.

Continued development of the vast network of rural secondary roads and city thoroughfares, which serve as feeder lines and provide land-access service, likewise has an important place in the over-all program, together with the repair or reconstruction of a large mileage of Federal and State primary highways not embraced within the interregional network.

I commend especially to the consideration of the Congress the recommendation that minimum standards of design and construction be established cooperatively with the States for all projects embraced within a designated interregional system. This, it seems to me, is

wise planning procedure, assuring the orderly development of the facilities which are necessary in the public interest with maximum long-range economy.

By Public Law 146, Seventy-eighth Congress, section 5, Commissioner of Public Roads Thomas H. MacDonald, was authorized and directed to make a survey of the need for a system of express highways throughout the United States, the number of such highways needed, the approximate routes which they should follow, and the approximate cost of construction, and to report to the President and to Congress, within 6 months after the date of the act, the results of the survey, together with such recommendations for legislation as deemed advisable. The act was approved on July 13, 1943.

The purposes of this directive by the Congress were identical with my own in requesting the investigation which has been made by the National Interregional Highway Committee. The Commissioner of Public Roads has served as the chairman of the Committee appointed, and the detailed investigations required have been made by the Public Roads Administration staff. The Commissioner of Public Roads has informed me that he concurs without exception in the report of the Committee, and desires that it be accepted as his report, complying with the direction of Congress in Public Law 146.

I am glad to endorse this suggestion, and ask that the Congress receive the report herewith transmitted as fulfilling the purposes of Congress in the directive laid upon the Commissioner of Public Roads.

Early action by the Congress in authorizing joint designation by the Federal Government and the several State highway departments of a national system of interregional highways is desirable, in order to facilitate the acquisition of land, the drawing of detailed project plans, and other preliminary work which must precede actual road construction.

These advance steps taken, the program can serve not only to help meet the Nation's highway transportation needs, but also as a means of utilizing productively during the post-war readjustment period a substantial share of the manpower and industrial capacity then available. A program of highway construction will, in addition, encourage and support the many diverse economic activities dependent upon highway transportation.

From personal experience, as Governor of a State and as President, I hope that the Congress will make additional studies in regard to the acquisition of land for highways.

In the interest of economy, I suggest that the actual route of new highways be left fluid. It is obvious that if a fixed route be determined in detail, the purchase price of rights-of-way will immediately rise, in many cases exorbitantly; whereas, if two or three routes—all approximately equal—are surveyed, the cheapest route in relation to right-of-way can be made the final choice.

Second, experience shows us that it is in most cases much cheaper to build a new highway, where none now exists, rather than to widen out an existing highway at a cost to the Government of acquiring or altering present developed frontages.

As a matter of fact, while the courts of the different States have varied in their interpretations, the principle of excess condemnation is coming into wider use both here and in other countries. I always

remember the instance of the farmer who was asked to sell a narrow right-of-way through his farm for a main connecting highway. From an engineering point of view it would have been as feasible to build the new highway across the dirt road that ran in front of his house and barn. Actually the owner received from a jury an amount equal to the whole value of the farm. The road was built. The owner of the land thereby acquired two new frontages. He sold lots on one frontage for the former value of his farm. A year or two later he sold the other frontage for the farm value of his farm. The result was that he still had his house and barn and 90 percent of his original acreage, and in addition he had received in cash three times the value of what the whole place was worth in the first instance.

It hardly seems fair that the hazard of an engineering survey should greatly enrich one man and give no profit to his neighbor, who may have had a right-of-way which was equally good. After all, why should the hazard of engineering give one private citizen an enormous profit? If there is to be an unearned profit, why should it not accrue to the Government—State or Federal, or both?

FRANKLIN D. ROOSEVELT.

THE WHITE HOUSE, *January 12, 1944.*

LETTER OF TRANSMITTAL

FEDERAL WORKS AGENCY,
Washington.

The PRESIDENT,
The White House.

MY DEAR MR. PRESIDENT: I transmit, with my approval, the final report of the National Interregional Highway Committee appointed by you on April 14, 1941.

In your letter of that date to the Honorable John M. Carmody, then Administrator, Federal Works Agency, you expressed the hope that as a result of the Committee's recommendations it would be possible to prepare detailed plans and specifications for the construction of a national system of interregional highways to utilize some of the manpower and industrial capacity which will be available at the termination of the war emergency.

The system of interregional highways which the Committee recommends has been found to meet in optimum degree the needs of interregional highway traffic, and I particularly commend to your notice the views of the Committee concerning the special importance of those sections of the system located within and near our larger cities and metropolitan areas.

The Defense Highway Act of 1941 authorized a Federal appropriation of $10,000,000 to be apportioned among the several States and matched by them to provide a fund for the making of surveys and plans for future highway construction. The funds authorized have been apportioned, and have been allotted in substantial part to the preparation of detailed plans and specifications for sections of highway included in the system the Committee recommends. The further application of these funds largely to the system, in my opinion a desirable requirement, will assure the availability of complete plans for the construction of important highways of an estimated cost of about $400,000,000.

More recently the Congress has authorized expenditure in each State of an amount of the unobligated balance of Federal-aid highway funds not exceeding the State's apportionment of a national total of $50,000,000, together with matching State funds, for additional surveys and plans for post-war highway construction.

By these two measures generous provision has been made for the preparatory work of surveying and planning which is necessary to assure the readiness of a large body of highway construction projects at the end of the war. There is, however, another equally important measure of preparation that must be taken if work on the planned projects is to begin promptly when peace returns. Rights-of-way for the planned improvements must be in hand; and funds for this purpose, clearly expendable during the war, should be made available. The recent act of Congress (Public Law No. 146, 78th Cong.) provides

for payment of the Federal share of the right-of-way costs of post-war projects only after construction has been actually begun. The States are required to advance from their currently reduced revenues, for the period of the war, the whole cost of rights-of-way acquired. Their inability to do this in many cases means that essential rights-of-way will be lacking when construction should be started, and the purpose of the wise provision that has been made for advance planning will thus be in large measure defeated. Moreover this right-of-way obstacle is likely to be most serious in the case of the very important projects that are being designed to relieve traffic congestion in cities, projects that will afford, if they are ready, large employment in the precise places where the need of employment will be greatest.

To remedy this unfortunate defect in the preparatory measures that have been taken, I strongly recommend congressional action to permit the Federal Government to pay promptly its proportionate share of the costs of rights-of-way acquired in anticipation of post-war highway improvements.

While the interregional system proposed constitutes, as a whole, the most heavily traveled section of the entire highway system of the Nation, it is obvious that there will be imperative need after the war for a large expenditure to repair the deterioration now in progress and eliminate critical deficiencies on other roads of national importance. Neither for planning nor for construction, therefore, do I believe it would be wise to limit the assistance of the Federal Government to routes included in the interregional system.

The plan suggested by the Committee, which would provide for the designation of an interregional system approximating that proposed, as, in effect, the primary routes of the Federal-aid system and, the appropriation of Federal funds for these and other classes of highways in accordance with need, but with particular provision for the urgent municipal needs, is in my opinion the wiser course. I, therefore, join with the Committee in its recommendation to that effect.

Sincerely yours,

PHILIP B. FLEMING,
Major General, United States Army,
Administrator.

JANUARY 5, 1944.

LETTER OF SUBMITTAL

NATIONAL INTERREGIONAL HIGHWAY COMMITTEE,
Washington, D. C.

Maj. Gen. PHILIP B. FLEMING,
Administrator, Federal Works Agency,
Washington, D. C.

SIR: In a letter under date of April 14, 1941, addressed to the Honorable John M. Carmody, then Administrator, Federal Works Agency, the President appointed a National Interregional Highway Committee of seven members to serve in an advisory capacity to the Administrator. He directed the Committee to review existing data and surveys and, upon completion of its review, to report to him not later than October 1, outlining and recommending a limited system of national highways designed to provide a basis for improved interregional transportation.

The President expressed the hope that our national needs would be paramount in the deliberations of the Committee and that as a result of its recommendations it would be possible to prepare detailed plans and specifications. This, the President, stated would permit us, upon the conclusion of the defense program, to utilize productively some of the manpower and industrial capacity then available to construct a national system of interregional highways.

The President also directed the Federal Works Agency to furnish such staff as necessary for the efficient functioning of the Committee and to compensate its members for travel expenses incurred.

The following persons were asked by the President to serve as members of the Committee:

Thomas H. MacDonald, Commissioner of Public Roads, Federal Works Agency.

G. Donald Kennedy, State highway commissioner, Lansing, Mich.

Bibb Graves, former Governor of Alabama.

C. H. Purcell, State highway engineer, Sacramento, Calif.

Frederic A. Delano, Chairman, National Resources Planning Board.

Harland Bartholomew, city planner, St. Louis, Mo.

Rexford Guy Tugwell, chairman, New York City Planning Commission.

All of those invited accepted membership and responded to the call for attendance at the initial meeting which was held at Washington, D. C., on June 24, 1941. At this meeting, the Committee elected as its chairman, Thomas H. MacDonald, Commissioner of Public Roads; and as its vice chairman, G. Donald Kennedy, State Highway Commissioner of Michigan. Mr. H. S. Fairbank, Public Roads Administration, was appointed secretary of the Committee and a small staff was supplied by the Public Roads Administration. The research and writing of this report are the work primarily of Mr. Fairbank, assisted by this staff. In addition to Mr. Fairbank, the

Committee desires to record its appreciation of the helpful services of this staff, and owes special acknowledgment to Harold E. Hilts, Edward H. Holmes, Arthur G. Siegle, Joseph Barnett, John T. Lynch, Olav K. Normann, D. W. Loutzenheiser, Clarence F. Rogers, David R. Levin, Conya L. Hardy, Mary S. Austin, and Margaret H. Davies for important contributions to the report.

Finding that it would be unable to complete its review and essential further investigations by the date originally set by the President, the Committee on October 2, 1941, submitted a preliminary report to the Federal Works Administrator and requested an extension of time which it was hoped would be of short duration.

Shortly thereafter the Committee was deprived of the counsel of one of its most valued members by the death of the Honorable Bibb Graves, former Governor of Alabama. The appointment of Dr. Rexford Guy Tugwell as Governor of Puerto Rico made it difficult for him to continue his active participation, and the exigencies of war have further greatly lengthened the time required. It is believed, however, that the final report transmitted herewith is not too late to serve the President's intended purpose to define the general character of a national system of interregional highways, the construction of which, if begun with the termination of the war emergency, will permit the productive utilization of much of the manpower and industrial capacity then likely to be available.

The Committee therefore hopes that you will approve its report and transmit it to the President for such favorable consideration and use as he may deem it to merit.

Very respectfully,

THOMAS H. MACDONALD, *Chairman.*
G. DONALD KENNEDY, *Vice Chairman.*
C. H. PURCELL.
FREDERIC A. DELANO.
HARLAND BARTHOLOMEW.
REXFORD GUY TUGWELL.

JANUARY 1, 1944.

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INTERREGIONAL HIGHWAYS

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INTRODUCTION

Construction of the present main highway system of the United States began in the later years of the horse-and-buggy era of highway transportation. At that time the Nation possessed a rural road network almost as extensive as at present, but it was almost wholly unimproved. By necessity all travel by road was of the shortest range.

In the cities, on the other hand, most of the streets were paved, some with cobble but many with smooth asphalt and brick. It was mainly the desire of new-fledged motorists in the cities for a comfortable ride into the country beyond the reaches of their paved streets, the similar deferred hope of more humble cyclists, and the competing aims of merchants in each town and city to enlarge or at least to hold, each his own rural trade, that prodded a long-talking "good roads movement" into actual construction.

The construction of roads begun, years of promiscuous building followed. Finally the builders awakened to the hopelessness of ever joining the thousands of disconnected little pieces of roads those years had produced. They began to realize the need for systematically classifying the vast road network and giving preferential order to the improvement of the portions of greatest use potential.

The original Federal Aid Road Act, passed in 1916, did not require such a classification. But by that time a few States, seeing the light, had created State highway systems of selected routes—usually those routes joining their several county seats and larger towns and cities.

To this sound principle of classification and preferential improvement—beyond any other the means of the rapid and orderly subsequent development of the main highways—the Federal Highway Act of 1921 gave endorsement and national extension. It required designation of the Federal-aid highway system and confined to this system all Federal funds then and thereafter to be appropriated for aid in road improvement—a restriction that was to remain in effect unaltered for many years.

At that time, the beginning of the century's third decade, the unimproved sections of roads chosen to make up the newly designated Federal-aid system were still far longer in the aggregate than the length of those that had been in some manner constructed. Most of the State highway systems were at the same early stage of development.

But the rapid upswing of motor-vehicle use had already set in. Each successive year more road-improvement revenue was coming in, largely from fees paid for vehicle registrations, from new motor-fuel

taxes and from the Federal Treasury. The purpose of State and Federal road agencies was to use these revenues to extend as rapidly as possible a useful measure of improvement to the entire selected mileage of main roads and thus to narrow as quickly as practicable the wholly unimproved gaps.

The measure of improvement considered necessary was usually less than the costly ideal which, by consuming much revenue on little mileage, would have delayed longer the improvement of other sections. It was expected that an initial limited improvement of each section would be followed in due course by a secondary stage when the progress of improvement of the system as a whole should permit the further expenditure. This was the policy of stage construction. It was a wise and useful policy as applied in the design of road surfaces. Its mistakes were its acceptance and fixation of obsolescent road alinement and its failure to anticipate the need of rights-of-way of greater width than those that in all previous time had been considered ample.

These are pardonable mistakes. When they were made, the high speeds at which motor vehicles can now travel were generally unforeseen and probably unforeseeable. The standards of alinement required by modern speed would then have been considered fantastic. The great increase of vehicle registration and traffic volume was anticipated too late, but even if it had been foreseen earlier, lack of necessary legal and popular sanctions would have prevented a forehanded acquisition of the wider rights-of-way that widened and divided roadways require.

First reasons for immediate designation of interregional system.—Past mistakes of main road location and rights-of-way neglect are understandable, but their consequences today emphasize the need for designating and preferentially improving an interregional system. For, paradoxically, the country's most important highways which will constitute the large part of such an interregional system are the ones that have suffered most in their improvement because of these mistakes.

The explanation of the paradox is that these roads, in recognition of their prime importance, were among the earliest of our highways to be durably improved. Structurally, many of these improvements are still embarrassingly sound; but in location, in traffic capacity, and in their lack of most of the features of modern highway design that make possible the safe operation of vehicles at high speeds, they are badly obsolescent.

Most of them have long since repaid their cost in the benefits they have yielded to the heavy traffic that has moved over them. As they are rebuilt, as soon they must be, they should be built to the highest modern standards, on locations and within rights-of-way where they will have the prospect of long and beneficial service. That such an improvement of these main arterial roads of the Nation may proceed consistently in all parts of the country, that all may agree upon the particular roads comprising the national routes in all regions and in all States, and that preparations may now be made for beginning the systematic improvement of these roads in the first post-war years—these are the first reasons indicating the necessity for immediate designation of an interregional system.

Other reasons for immediate designation.—Another consequence of past policies is the widely recognized gross inadequacy of the accommodation afforded by city streets for the heavier streams of arterial travel. Two decades ago the most obstructive deficiencies existed on the rural roads. City streets were relatively ample in their traffic capacity. Today these conditions are reversed. It is within and in the vicinity of the cities and metropolitan areas that through travel now experiences its most serious resistance and delays, resistance and delays that are abundantly shared by the heavy intraurban local traffic that tends to congregate on the same arterial routes.

Twenty years ago when the Federal Highway Act and many of the State highway enactments prohibited the expenditure of limited Federal and State funds for improvement of the transcity connections of the Federal-aid and State highway systems, the prohibition was not unreasonable. It was instead a necessary and logical recognition of the superior need of rural highway improvement. Now, with congestion of the transcity routes replacing rural highway mud as the greatest of traffic barriers, emphasis needs to be reversed and the larger expenditure devoted to improvement of the city and metropolitan sections of arterial routes. That the particular locations of these routes may be agreed upon in common by Federal, State, and municipal authorities who will share the responsibility for arterial highway improvement, that the desirable standards of that improvement may be established and commonly accepted, and that plans may at once be laid for a prompt post-war beginning of the highly essential construction work—these are other compelling reasons for the designation of an interregional system.

Optimum system proposed.—Clearly recognizing the present need, the President in his letter of April 14, 1941, to the Administrator, Federal Works Agency, appointed the National Interregional Highway Committee and directed it to review existing data and surveys and to outline and recommend a limited system of national highways designed to provide a basis for improved interregional transportation.

In all its deliberations and in the recommendations which follow, the Committee has been guided by the President's expressed hope that it would hold national needs paramount over the needs of sections and localities. Consistent with the purpose of interregional connection and the limitation of total mileage, it is believed that the system recommended will serve as large a proportion of the total highway traffic of the Nation as it is possible to attract to any system of the same extent.

The cities and metropolitan areas of the country are known to include the sources and destinations of much the greater part of the heavy flow of traffic that moves over the Nation's highways. The system of interregional highways proposed, within the limit of the mileage adopted, connects as many as possible of the larger cities and metropolitan areas regionally and interregionally. For this reason, although in miles it represents scarcely over 1 percent of the entire highway and street system, it will probably serve not less than 20 percent of the total street and highway traffic.

The wealth of factual information available to the Committee indicates clearly that any other system, either materially larger or smaller than that proposed, would have a lesser average utilization. The

limiting mileage adopted may therefore be accepted with confidence as very close to the optimum mileage which will afford the greatest possible service per mile.

The Committee had for its consideration all the data amassed by the Public Roads Administration for its report, Toll Roads and Free Roads, which was transmitted by the President to the Congress in 1939 and published as House Document No. 272, Seventy-sixth Congress, first session. In that report two systems were defined, one of approximately 14,200 miles and the other of about 26,700 miles. The latter was proposed as an interregional system.

Subsequently, the Public Roads Administration reexamined its data and made minor changes and small additions to the published system, increasing its length to 29,300 miles. The facts suggesting these changes were available for the Committee's review, as were also the voluminous data amassed for selection of the strategic network of principal highway routes shown on a map approved by the Secretary of War, as revised May 15, 1941.

Finally, at the Committee's direction, a staff supplied by the Public Roads Administration made studies of three additional systems, one of approximately 48,400 miles, one of 36,000 miles, and one of about 33,920 miles which is the recommended system.

In the selection of all of these systems, one common objective prevailed: To incorporate within each of the several mileage limits adopted, those principal highway routes which would reach to all sections of the country, form within themselves a complete network, and jointly attract and adequately serve a greater traffic volume than any other system of equal extent and condition.

All facts available to the Committee point to the sections of the recommended system within and in the environs of the larger cities and metropolitan areas as at once the most important in traffic service and least adequate in their present state of improvement. These sections include routes around as well as into and through the urban areas. If priority of improvement within the system be determined by either the magnitude of benefits resulting or the urgency of need, it is to these sections that first attention should be accorded.

Obviously, it is not possible by any limited highway system, whatever the relative importance of its constituent routes, to serve all the needs of the Nation's traffic. Nor is it reasonable to assume that in and near the cities the routes included in such a limited system will if improved, provide a complete solution to the serious problem of city traffic congestion. Particularly in the cities, many other routes are probably of substantially equal if not greater importance, and improvement of the system routes should, therefore, not be advanced ahead of others of similar or greater local importance. In this connection the Committee has been restricted in its choice because the President directed it to select an interregional rather than a local system, and to consider national above local needs.

The Committee believes it would be a mistake to regard the interregional system as an object of exclusive attention, even by the Federal Government, or to concentrate upon it all or a disproportionate part of any effort and funds that may be applied to highway improvement. The Federal Government has substantial interests in many other roads and possibly other city arteries. Its assistance should not be confined to the routes included in the recommended limited system.

Nevertheless it is important, both locally and nationally, to recognize this recommended system and the routes that comprise it for what they are—as that system and those routes which best and most directly join region with region and major city with major city.

And with such recognition, it is desirable, in all Federal, State, and local highway improvement programs, to give to this system and to these routes, promptness and preference of attention, consistency of plan, and a large share of available financial means. This will be necessary for its progressive and balanced improvement at a rate sufficient to halt the present obsolescent trend of constituent routes and to substitute a reasonably rapid movement toward complete adequacy.

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THE RECOMMENDED INTERREGIONAL HIGHWAY SYSTEM

The general location of the routes comprising the recommended interregional highway system is shown on the map, figure 1.

The total length of the system is approximately 33,920 miles. This represents 1.04 percent of the 3,267,717 miles of rural roads and urban streets in the United States.

The approximate length of rural sections of the system, 29,450 miles, is 0.99 percent of the 2,964,677 miles of rural roads.

The approximate length of urban sections, 4,470 miles, is 1.48 percent of the 303,040 miles of urban streets.

By regions [1] (fig. 2) and States, table 1 shows the approximate lengths of the recommended system and of its rural and urban sections, and the percentage relations of those lengths to the total length of all road and streets and to the total lengths of all rural roads and all urban streets, respectively.

Located for Service

In relation to cities.—The recommended system connects [2] directly all cities of 300,000 or more population. It is the smallest system that provides these connections.

It reaches 59 of the 62 cities of population between 100,000 and 300,000 persons, and is superior in this respect to the 48,300-mile and 78,800-mile systems previously investigated by the Public Roads Administration.

The recommended system reaches directly only 82 of the 107 cities of population between 50,000 and 100,000. The 48,300-mile system reaches only 91 and the 78,800-mile system only 95 of the cities of this size, and hence are little superior to the recommended system.

[1] For purposes of its study the Committee considered the United States as divided into regions. These regions are composed of contiguous States grouped together by the U. S. Bureau of the Census because of generally similar population and economic characteristics (see appendix 1, tables 1 and 2).

[2] Table 2 summarizes the numbers of cities of each size reached by each system in each region.

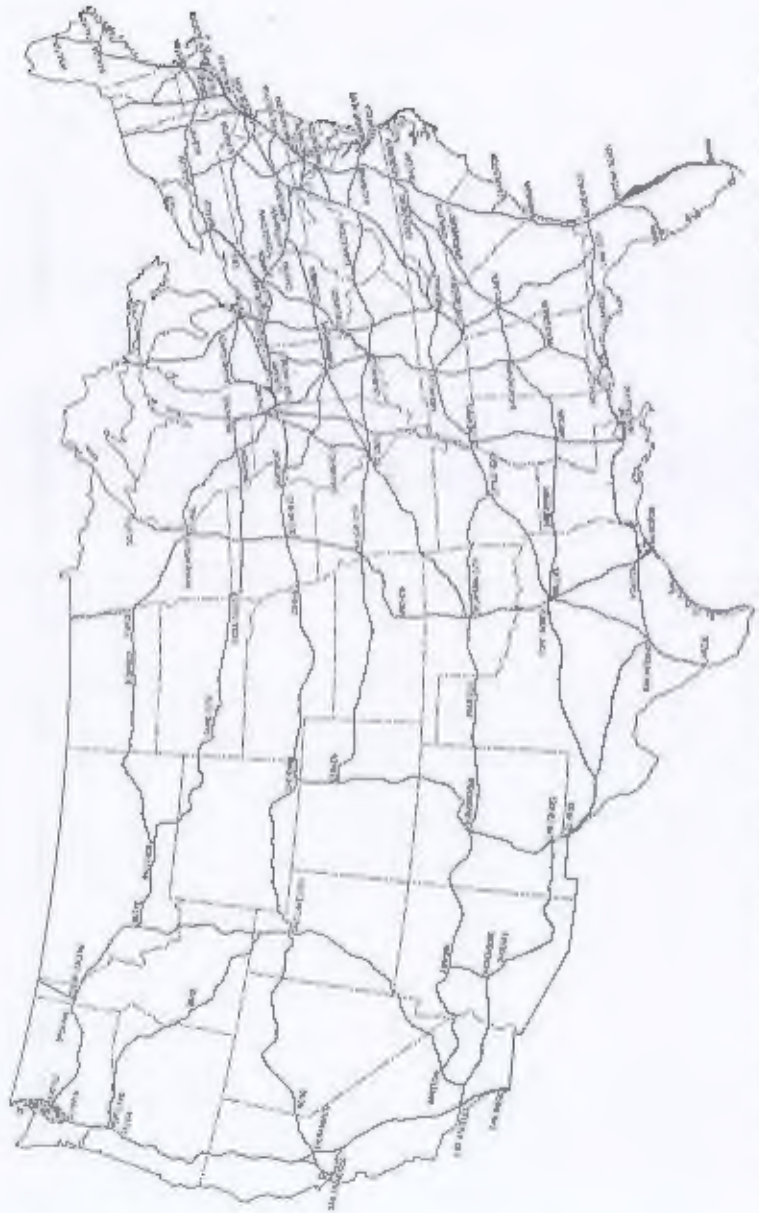

FIGURE 1.—The general location of routes of the recommended interregional highway system. Total length of the system is 33,920 miles.

DIAGRAM 2.—Regions of the United States, based on groupings of the States by the United States Bureau of the Census.

TABLE 1.—*Lengths of the recommended system and its urban and rural sections, and the percentage relationships of these lengths to the total lengths of rural roads and streets and to the total lengths of all rural roads and urban streets, respectively*

Region and State	Length of interregional system		Ratio to total road and street mileage			
	Rural sections	Urban sections	Total	Rural sections (percentage relationship to total rural road mileage)	Urban sections (percentage relationship to total urban street mileage)	
	Miles	Miles	Miles	Percent	Percent	Percent
United States	20,450	4			6	64
New England	1,110	3	1		8	78
Maine	410	40	450	1.97	1.78	3
New Hampshire	100	30	130	.89	4.0	2.46
Vermont	170	30	200	1.41	1.26	4.4
Massachusetts	280	80	360	1.45	1.48	6.3
Rhode Island	30	10	40	1.02	1.21	
Connecticut	140	40	180	1.26	1.15	4
Middle Atlantic	1,910	510	2,370	.97	9	76
New York	1,020	170	1,190	.85	.95	11
New Jersey	70	70	200	.72		6
Pennsylvania	810	260	1,070	1.17	.97	69
East North Central	4,000	990	4,990	.98	9	4.35
Ohio	760	290	1,040	1.02	.95	65
Indiana	700	160	850	1.10	.95	
Illinois	1,250	340	1,590	1.26	1.23	76
Michigan	700	185	885	.85	.6	1.56
Wisconsin	590	75	665	.88	.55	47

TABLE 1.—*Lengths of the recommended system and its urban and rural sections, and the percentage relationships of these lengths to the total lengths of rural roads and streets and to the total lengths of all rural roads and urban streets, respectively*—Continued

Region and State	Length of interregional system		Ratio to total road and street mileage			
	Rural sections	Urban sections	Total	Rural sections (percentage relationship to total rural road mileage)	Urban sections (percentage relationship to total urban street mileage)	
	Miles	Miles	Miles	Percent	Percent	Percent
West North Central	4,890	470	5,360	3	50	91
Minnesota	450	90	540	1.41	30	15
[illegible]	5	5	10	.75	72	90
[illegible]	20	65	85	.6	69	53
[illegible]	610	35	650	4	64	84
[illegible]	6	30	8	.43	8	36
[illegible]	4,20	40	460	1.44	42	80
[illegible]	10	60		1.56	60	83
South Atlantic	4,490	660	6,150	3	102	2.81
[illegible]	30	5	35	.57	50	96
[illegible]	200	20	220	1.30	26	1.63
[illegible] of Columbia		15	15	3.75		1.75
Virginia	810	75	885	.58	1.66	1.84
West Virginia	80	45	125	.65	60	2.14
North Carolina	570	10	650	.98	80	1.85
South Carolina	610	4	400	.84	70	1.53
Georgia	10	140	150	.4	65	2.60
Florida	5	240	290	2.7	9.2	7.15
East South Central	2,6	400	3,0	2		4.69
[illegible]	610	85	695	.4	4.50	2.37
[illegible]	220	100	320	.11	3.48	1.65
[illegible]	710	210	910	.28	4.20	4.44
[illegible]	440	85	520	.82	70	1.29
West South Central	4,130	40	4,170	.4	4.00	.72
[illegible]	460	60	520	.81	80	.40
[illegible]	440	90	530	.91	1.20	.2
[illegible]	740	80	820	.52	52	.76
[illegible]	2,460	260	2,720	.14	37	.4
Mountain	850	340	1,190	.9	70	2.40
[illegible]	560	35	870	1.67	42	.69
[illegible]	660	80	880	1.96	1.02	2.28
[illegible]	1,050	240	1,290	2.67	1.50	3.63
[illegible]	640	45	685	.92	58	.77
[illegible]	1,040	40	1,080	1.02	1.50	3.19
[illegible]	1,10	20	1,20	4.97	3.10	.83
[illegible]	1,30	1,5	2,80	2	2	3.4
[illegible]	1,52	20	1,54	2.30	2.50	4.75
Pacific	2,740	320	3,060	40	40	.6
[illegible]	1,25	5	1,30	.80	.04	.4
[illegible]	1,0	80	1,1	.4	1.4	.70
California	1,540	2,5	1,8	.8	55	1.26

TABLE 2.—*Total number of cities of each population class and number connected by each of several highway systems, by regions*

Region	1,000,000 or more: Total number	1,000,000 or more: Number connected	500,000 to 1,000,000: Total number	500,000 to 1,000,000: Number connected	250,000 to 500,000: Total number	250,000 to 500,000: Number connected	100,000 to 250,000: Total number	100,000 to 250,000: Number connected	50,000 to 100,000: Total number	50,000 to 100,000: Number connected	25,000 to 50,000: Total number	25,000 to 50,000: Number connected	10,000 to 25,000: Total number	10,000 to 25,000: Number connected	Total number connected
[illegible]-mile highway system															
United States	5	5	9	9	13	10	52	33	107	35	213	50	665	101	243
New England			1	1						8	3	7	19	1	43
Middle Atlantic	2	2	2	2	3	1		4	5	8	14	8	9	54	46
East North Central	2	2	3	1	3	2	7	4	10	24	9	28	5		76
West North Central			1	1	2		7		5	1		7	45		11
South Atlantic			2	2	1			4		8	5	0	14	10	25
East South Central					1		1		4	1	0	3	1	3	1
West South Central					2		3		6	4	2	3	8	13	24
Mountain					1	1			2	1			26		17
Pacific	1	1	1	1	3	3	3	5		6	1	17	43	37	54
20,[illegible]-mile system															
United States	5	5	9	9	13	[illegible]	52	[illegible]	107	45	[illegible]	[illegible]	[illegible]	[illegible]	351
New England								6	1	2	38		5	14	34
Middle Atlantic	2	2	2	2	3	2	17	7	24	5	34		6		49
East North Central	2	2	2	2	3	1	11	4	2	13	42		39	6	62
West North Central				1	2	2	8	3	4	3	4	1	44		6
South Atlantic			2	2	1	1		4	1	4	37	16	58	21	43
East South Central					1		3		4	3	10	6		9	24
West South Central					2	2	5	5	4	2	3	5	54	14	33
Mountain					1		1	1	2	2		4	35	12	70
Pacific	1	1	1		3	3	4	4	2	6	17	1	1	37	46
2[illegible]-mile system															
United States	5	5	9	9	13	13	52	46	107	65	213	[illegible]	665	[illegible]	492
New England								5		9	14	15		29	44
Middle Atlantic	2	2	2	2	2	2	11	5	21	16	34	19	[illegible]		105
East North Central	2	2	2	2	3	3	8	4	21	15	41	21	[illegible]		[illegible]
West North Central			1		2	2	6		5	3	7	4	[illegible]	5	41
South Atlantic			2	2	1	1			1	9	30	60	58	27	47
East South Central					1	1	5	5	1	3	15	2		7	34
West South Central					2		5	5	0	6	13	4		5	34
Mountain					1				2	2		4	26	3	27
Pacific	1				3	3	6	6	1	8	17	14	61	27	57
Recommended system 33,920 miles															
United States	5	5	9	9	13	10	52	49	107	88	213	121	665	295	577
New England			1					5	5	8	34	20	75	35	70
Middle Atlantic	2	2	2	2	3	3	1	17	21	25	3	[illegible]	93	6	133
East North Central	2	2	[illegible]	2	3	1	8	9	23	18	60	21	76	5	123
West North Central			1		2	2	5	5	3	3	[illegible]	4	65	16	43
South Atlantic			2	2	1	1	7	7	17	12	30	12	68	33	67
East South Central					1	1	5	5	4	4	10	6	31	1	27
West South Central					2	2	5	5	9	2	13	6	[illegible]	27	41
Mountain					1	1			2	2	7	5	76	3	22
Pacific	1	1	1	1	3	3	5	5	[illegible]	8	17	14	47	37	57

TABLE 2.—*Total number of cities of each population class and number connected by each of several highway systems, by regions*—Continued

Region	1,000,000 or more: Total number	1,000,000 or more: Number connected	500,000 to 1,000,000: Total number	500,000 to 1,000,000: Number connected	250,000 to 500,000: Total number	250,000 to 500,000: Number connected	100,000 to 250,000: Total number	100,000 to 250,000: Number connected	50,000 to 100,000: Total number	50,000 to 100,000: Number connected	25,000 to 50,000: Total number	25,000 to 50,000: Number connected	10,000 to 25,000: Total number	10,000 to 25,000: Number connected	Total number connected
[illegible]-mile system															
United States	5	5	9	9	13	6	52	50	107	96	213	122	665	[illegible]	507
New England								1	4	11	50	21	71	25	70
Middle Atlantic	2	2		2	3	3		1	24	20	84	27	113	70	136
East North Central	2	2	3	3	3	3	1	8	23	8	44	32	28	64	120
West North Central			1		3	1		0	8		2	5	64	3	60
South Atlantic			2	2	1	1	7	7	5	15	25	4	66	32	69
East South Central					1			5	4	4		5		1	27
West South Central					2	2	3	5	6	2	43	0		3	41
Mountain					1		1	1	3	2	7	7	26	3	22
Pacific	1		1		3	3	5	6	7	6	17	4	47	37	67
48,300-mile system															
United States	5	5	9	9	13	10	52	50	107	94	213	[illegible]	665	351	674
New England				1			11	11	1	47	31	24	70	50	74
Middle Atlantic	2	2	3	2	3	4	1	15	24	30	38	25	63	8	140
East North Central	2	2	2	2	3	3	1	7	23	20	40	15	114		149
West North Central			1	1	2	2	6	6	4	6	2	6	69	27	46
South Atlantic			2	2	1	1	7	7	17	16	20	14	64	44	83
East South Central					1	1	5	5	4	4	7	7	7	20	37
West South Central					2	2	5	5	9	8	13	9	60	29	53
Mountain							1	1	2	2	7	6	26	15	20
Pacific	1			1	3	3	5	6	7	2	17	17	47	33	67
78,800-mile system															
United States	5	5	9	9	13	10	52	[illegible]	107	105	213	180	665	444	807
New England			1	1			1	11	1	8	31	3	59	54	103
Middle Atlantic	2	2	2	2	3	3	1		24	25	58	32	63	103	170
East North Central	2	2	2	2	3	3	1	0	23	27	101	41	58	70	151
West North Central				1	2	2	6	6	5	5	2	7	64	50	85
South Atlantic			2	2	1	1	7	7	7	7	20	15	64	65	98
East South Central							5	5	4	4	7	9	7	20	69
West South Central					2	2	5	5	9	9	13	13	50	28	67
Mountain					1		1	1	2	2		6	26	15	24
Pacific	1	1		1	3	3	5	5	7	7	17	17	47	47	81

It is mainly in their connections with cities under 50,000 population that the 48,300- and 78,800-mile systems show marked superiority to the recommended 33,920-mile system. The latter connects 121 of the 213 cities of population between 25,000 and 50,000, as compared with 141 connected by the 48,300-mile system and 180 by the system of 78,800 miles. The recommended system reaches directly only 295 of the 665 cities of 10,000 to 25,000 population, whereas the 48,300-mile system reaches 351, and the 78,800-mile system 444. Thus not even the largest of the systems studied is sufficiently extensive to reach all cities of these two smallest population groups. To reach all

cities of 10,000 or more population, it has been determined that the largest system investigated would have to be increased by 14,700 miles.

Any effort to reach a larger number of the cities under 50,000 population than are connected by the recommended system, it is believed, must result in a lowering of the average traffic volume served by the system as a whole. The gain to a few of our smaller cities would, therefore, be accomplished at the expense of a diminishing return in traffic service for the system as a whole. The committee decided this would not be warranted.

The map [illegible] shows the recommended system in relation to the location of all cities of the several population groups larger than 10,000. This map shows how directly the recommended system joins the larger cities, and the remarkable extent to which most of these cities are served as hubs of their respective regions.

The largest cities not directly connected are shown to be Akron, Canton, and Youngstown in Ohio, but all of these are passed in close proximity. The difficulties that prevent immediate connection of these cities are evident—junction cannot be made without introducing either what appears to be an unwarranted local duplication of routes, or a considerable indirection of approach to the commanding nearby city of Cleveland.

On the basis of the 1940 Census, the Bureau of the Census defined a certain area in connection with each city of 50,000 or more population as a metropolitan district, except that two or more such cities were sometimes included in one district. The number of metropolitan districts totals 140.

The general plan was to include in each district, in addition to the central city or cities, adjacent contiguous civil divisions or incorporated places having a population of 150 or more per square mile. In some districts, a few less densely populated contiguous divisions were included on the basis of special qualifications. Occasionally only a portion of a minor civil division was included if the division was large in area and had its population principally concentrated in a small section in or near the central city.

The districts defined are, therefore, not political units, but rather areas of the thickly settled territory in and around the country's larger cities or groups of larger cities. They tend, in general, to be more or less integrated areas, with common economic and social, and often, administrative interests. As will be seen from the map, figure 4, the recommended inter-regional system connects directly or passes in very close proximity to all but 10 of these districts.

Exception in relation to population basis.—A statement of the numbers of cities reached directly by the recommended system does not convey an entirely accurate impression of the nearness of approach of the system to the homes of a large proportion of the urban population of the United States. Although only 54.5 percent of all cities of 10,000 or more population are located directly on the system the aggregate population of these cities is 82.6 percent of the total urban population of the Nation. With slight exception in two

FIGURE 3.—The recommended interregional system in relation to the location of cities of various population groups.

FIGURE 4.—The recommended interregional system in relation to the 2,478 cities having 10,000 or more population as enumerated by the Bureau of the Census.

groups, the cities directly connected are the largest of their respective population groups. This is shown in table 3.

TABLE 3.—*The number and population of all cities of the United States above 10,000 population, and the number, population, and percentage of total numbers and total population for such cities directly connected by the recommended system by population groups*

Population group	All cities of 10,000 or more population		Cities of 10,000 or more population on the recommended system			
	Number	Population	Number	Percent of the number in the group	Population	Percent of total population
		1,000 persons			1,000 persons	
Over 1,000,000	6	9,113	5	83.3	5,231	57.4
500,000 to 1,000,000	9	11,457	9	100.0	6,945	60.6
250,000 to 500,000	16	6,102	13	81.3	5,805	95.1
100,000 to 250,000	62	9,525	59	95.2	9,095	95.5
50,000 to 100,000	107	7,844	82	76.6	5,859	74.7
25,000 to 50,000	253	7,917	172	68.0	5,108	65.0
10,000 to 25,000	995	11,007	205	44.4	4,441	40.3
A total of 10,000 or more population	1,478	63,715	1,057	64.5	52,805	82.9

A still more graphic picture of the population reasons for choice of the particular routes recommended will be found in figure 5. This shows by dots the distribution of the whole population of the United States, each dot representing a population node of 2,000 persons. Here it will be seen that the various routes not only have their principal local termini or hubs in the larger cities but also pass en route between these hubs, through or very close to the denser clusters of population in small towns and populous rural areas. Indeed, the courses of the recommended routes are shown by this map to be in most instances the inevitable selections, if service of population is to be considered important in the choice.

In a few instances apparent lack of correlation in this respect is evident, and a local shift of the recommended route may be found desirable after further and more intensive study. In such part or study consideration should also be given to local adjustment of the recommended routes to a closer conformity, if such be possible, to the larger concentrations of rural population.

That such conformity already exists in large measure is indicated by the map figure 6, which is by intensity of shading the gradation of average density of rural population, county by county. Here, again, the remarkable manner in which the recommended routes trace their courses along the country's most populous bands of territory is apparent at a glance. Few if any instances occur in which the recommended route locations can obviously be materially improved, except by excessive multiplication of local mileage.

As further evidence of the advantageous selection of the recommended routes for service of the rural population, the data presented in table 4 show that although the routes traverse only 1,056 or 34.3 percent of the total number of 3,076 counties[1] in the United States

[1] For statistical purposes, parts of Yellowstone National Park in Idaho and Montana are counted as separate counties in this report. For the same reason the district of Alaska is included as 4 counties and various independent cities, as Baltimore, Md., and Fairfax, Va., are lumped with the respective counties of which they might logically be considered geographically a part.

FIGURE 5.—The recommended interregional system in relation to the distribution of the whole population of the United States.

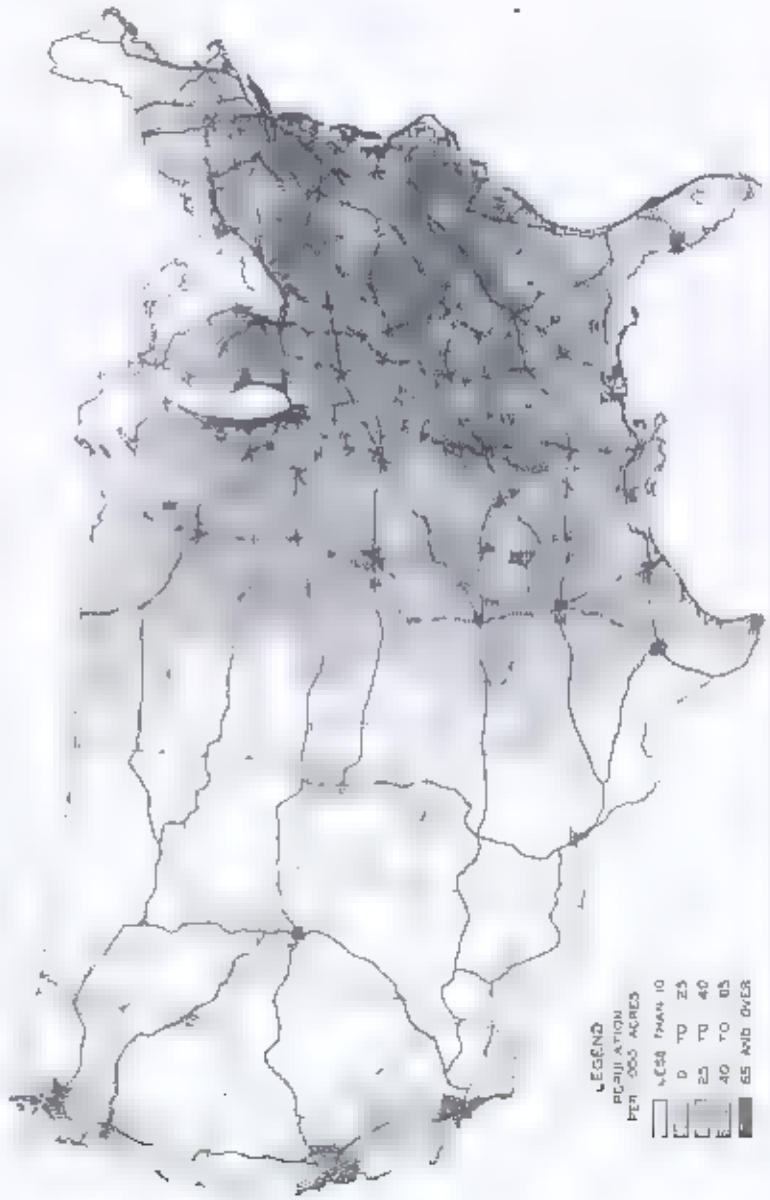

FIGURE 6.—The recommended interregional system in relation to the density of rural population distribution in the United States.

TABLE 4.—*The number and rural population of all counties in the United States, and the number and rural population, and percentage of total number and total rural population for counties traversed by the recommended system, by regions*

Geographic region	All counties		Counties traversed by recommended system			
	Number	Rural population	Number	Percent of total number	Rural population	Percent of total rural population
		1,000 persons			1,000 persons	
United States	3,076	57,245	1,068	34.8	25,862	45.2
New England	67	3,017	37	55.2	1,465	48.6
Middle Atlantic	150	8,380	78	52.0	3,286	39.2
East North Central	436	9,182	181	41.5	4,827	52.6
West North Central	825	7,526	253	30.5	3,169	42.1
South Atlantic	558	10,901	172	31.0	4,290	39.4
East South Central	364	7,510	121	33.2	3,865	51.5
West South Central	476	7,881	153	32.1	3,163	40.1
Mountain	280	2,378	108	38.6	1,176	49.4
Pacific	133	3,377	66	49.6	2,196	65.1

See text note 3 of foldout page

these counties traversed were inhabited in 1940 by 25,862,000 persons or 45.2 percent of the entire rural population of the United States. The evidence of appropriate selection in this respect is marked in each geographic region [illegible] striking in regions with large variations of rural population. It is less conspicuous in regions where rural population is more uniformly spread, with either a relatively high or relatively low average density.

[illegible] a system of interregional highways that may be designated should, within the limits of mileage adopted, provide transportation facilities for as much as possible of the manufacturing industry of the country. Where manufacturing activity exists in greatest volume, [illegible] the points of origin and destination of the greatest volumes of motortruck traffic. The interregional system should provide for the service of this traffic as well as passenger-car traffic.

In expressing this view, however, the Committee does not suggest that there should be special highway facilities for the accommodation or encouragement of long-distance trucking. All the evidence assembled by highway planning surveys points to the fact that the range of motortruck hauls is comparatively short. There is nothing to indicate the probability of an increasing range of such movements in the future.

The length of truck hauls will be determined in the future as it has been in the past, by the competitive advantages at various distances of other modes of transportation. The probable early development of an efficient commercial air-freight service, together with the keener competition of a rejuvenated rail service, would seem to forecast a future shortening rather than a lengthening of average highway-freight hauls.

The volume of highway-freight movements in the future may be expected to be greatest on highways joining the centers of greatest industrial activity. Such highways should be incorporated, as far as possible, in the interregional system.

FIGURE 7.—The recommended interregional system in relation to cities of various degrees of manufacturing importance, as indicated by the value added by manufacture in each city as reported by the Bureau of the Census.

To test the adequacy of the recommended system from the standpoint of industrial transportation, the committee has used the census reports of values added by manufacturing industries located in the various cities of the country, as a measure of the relative manufacturing activity of these cities and of the relative probability of intercity highway freight movement.

These values for all cities of 10 000 or more population are shown on the map, figure 7, by circles of various sizes. Here again, as in the similar map (fig. 3) representing the relative populations of cities it will be seen that the routes of the recommended system connect the cities represented by the largest circles, and within the limit of total mileage adopted, join or closely approach en route about as many as possible of the cities of larger manufacturing importance.

A comparison of figures 3 and 7 will show that while slight differences exist in the relative importance of cities when they are measured on the one hand by their populations and on the other by the values added by their manufactures, on the whole the similarity of the measurements is marked.

This similarity is further evidenced by a comparison of tables 3 and 5. The latter shows the value of manufactures added in the cities of 10 000 or more population that are on the system, in relation to the corresponding totals for all cities of the same population range, while table 3 shows the population relations. In both instances the cities on the system are shown to be important beyond their number.

A comparison of the number of cities of 10,000 or more population reached directly by the recommended system and other systems investigated, and the values added by manufacture in these cities is shown in figure 8. From this figure it will be clear that the largest system investigated, 78,840 miles, connects directly with only 75 percent of the cities of 10,000 or more population, and that these connected cities account for 96 percent of the value added by manufacture in this population group.

To reach directly all cities of 10,000 or more population it has been determined that the 78,840-mile system would have to be increased by at least 14,100 miles. This new and larger mileage totaling 92,900 miles, is shown in figure 8 as the abscissa of the point representing 100 percent of the number of cities of 10,000 or more and of the value added by manufacture in all such cities.

From this figure it is manifest that the cities of 10,000 or more population connected by the recommended system are in general the more important manufacturing cities. Numerically, they are 75 percent of all cities of more than 10,000 population, they account for 83 percent of the total value added by manufacture in all such cities.

In contrast, the system reaching all of the cities is nearly three times as large and serves only an additional 17 percent of manufacturing activity.

It is therefore concluded that the recommended system closely approximates the system of optimum extent from the standpoint of service to manufacturing industry.

Location in relation to agricultural production. It has previously been shown that the recommended system traverses 1,056, or 34.3 percent of the 3,076[1] counties of the United States and that the counties traversed include the places of residence of 47.2 percent of the total rural population of the country. On further examination it is found that the counties traversed account for 43.4 percent of the total value of all farm products sold or traded in the Nation as a whole. Per county, the average value of marketed products in the counties traversed is 46 percent higher than in the remaining more numerous counties.

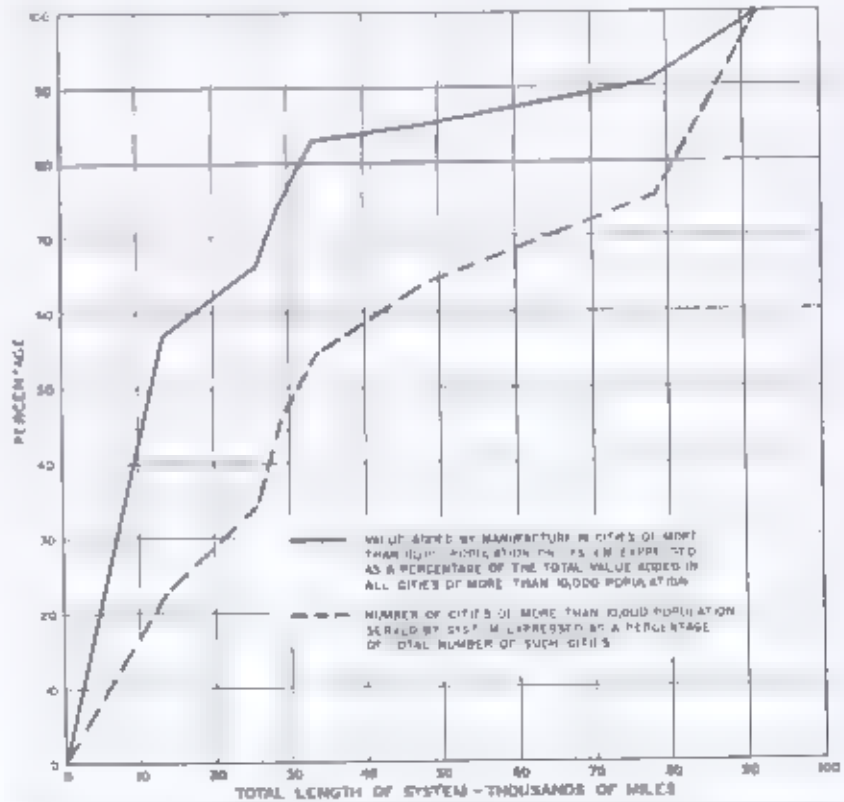

FIGURE 8.—The number of cities of more than 10,000 population directly connected by various highway systems investigated, and the value added by manufacture in such cities, expressed as percentages of the total number of cities of more than 10,000 population and the total value added by manufacture in all such cities.

[1] See footnote 3.

TABLE 5.—*The number of all cities over 10,000 population in the United States, the value added by manufacture in all such cities, the number and percentage of such cities on the recommended interregional system, the value added by manufacture in cities on the system, and the percentage relation of this value to the corresponding total for all cities of the same population range, by population groups of cities*

Population groups	All cities of 10,000 or more population		Cities of 10,000 or more population on the recommended system			
	Number	Value added by manufacture	Number	Percentage of total number	Value added by manufacture	Percentage of total value added by manufacture
		Million dollars			*Million dollars*	
Over 1,000,000	5	4,716	5	100.0	4,716	100.0
500,000 to 1,000,000	9	3,021	9	100.0	3,021	100.0
250,000 to 500,000	16	1,650	16	100.0	1,650	100.0
100,000 to 250,000	82	5,518	69	84.2	4,561	82.6
50,000 to 100,000	127	2,295	82	76.5	1,631	71.1
25,000 to 50,000	213	2,142	121	56.8	1,153	53.8
10,000 to 25,000	585	2,454	264	44.4	1,328	54.1
All cities of 10,000 population and over	1,077	18,127	567	54.5	15,065	83.0

[1] Value of products less cost of material, fuel, purchased electric energy, and contract work.

Data from Bureau of the Census, Census of Manufactures, 1939

By geographic regions this relation is shown in table 6, which indicates that [illegible] regions except the Middle Atlantic the counties traversed are well above the average in the aggregate value of their marketed agricultural products.

TABLE 6.—*The number and value of agricultural products marketed in all counties, and the number and production value and percentage of total number and total production value, for counties traversed by the recommended system, by regions*

Geographic region	All counties		Counties traversed by the recommended system			
	Number	Value of products sold and traded 1939	Number	Percent of total number	Value of products sold and traded 1939	Percent of total value of products sold and traded
		1,000 dollars			*1,000 dollars*	
United States	3,076	6,581,076	1,068	34.9	2,863,236	43.3
New England	67	208,305	37	55.2	149,615	71.8
Middle Atlantic	150	514,602	75	52.0	259,471	50.4
East North Central	436	1,362,462	183	41.6	595,507	43.7
West North Central	615	1,870,716	151	24.2	565,274	30.4
South Atlantic	555	599,296	173	31.0	232,464	38.1
East South Central	364	422,981	121	33.2	166,729	39.7
West South Central	470	783,296	152	32.3	282,393	36.6
Mountain	290	449,710	108	36.6	215,616	48.0
Pacific	133	555,874	56	42.1	339,164	61.4

FIGURE 9.—The interregional system in relation to the value of farm products sold or traded by area distributed into the United States

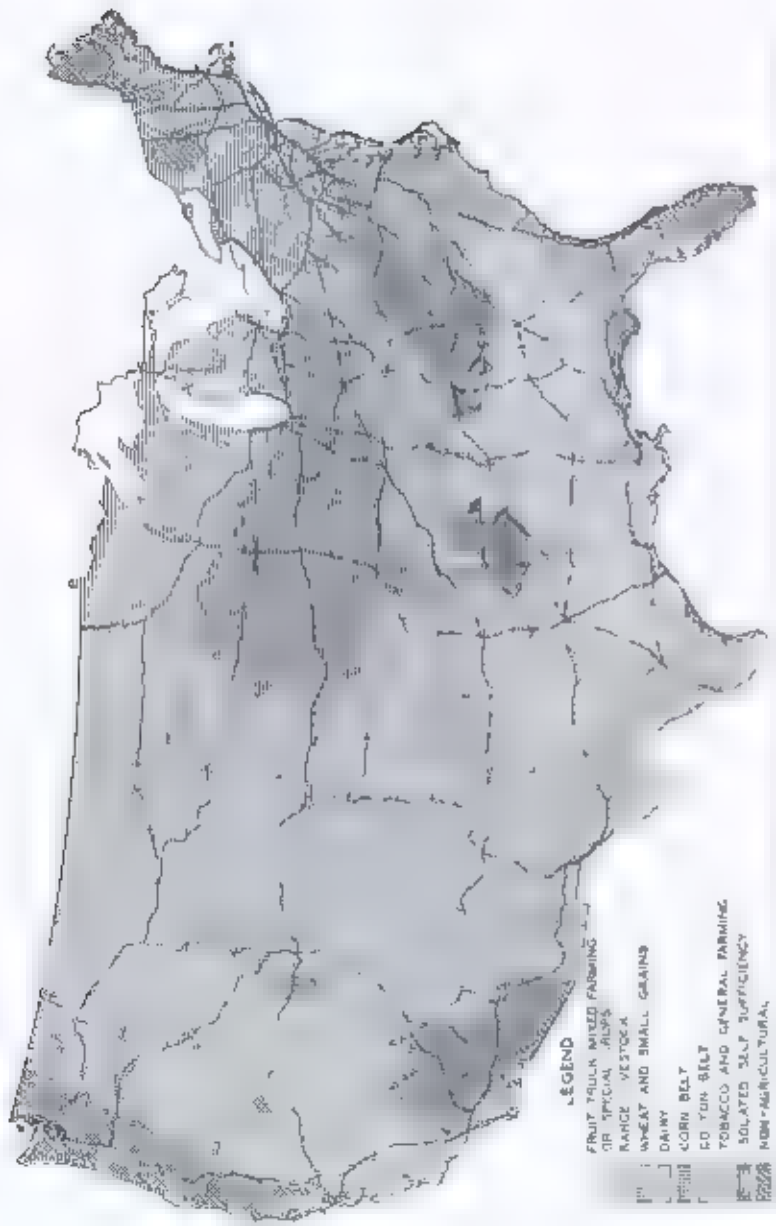

FIGURE 10.—The general types of farm production in areas traversed by the recommended interregional system and other areas of the United States

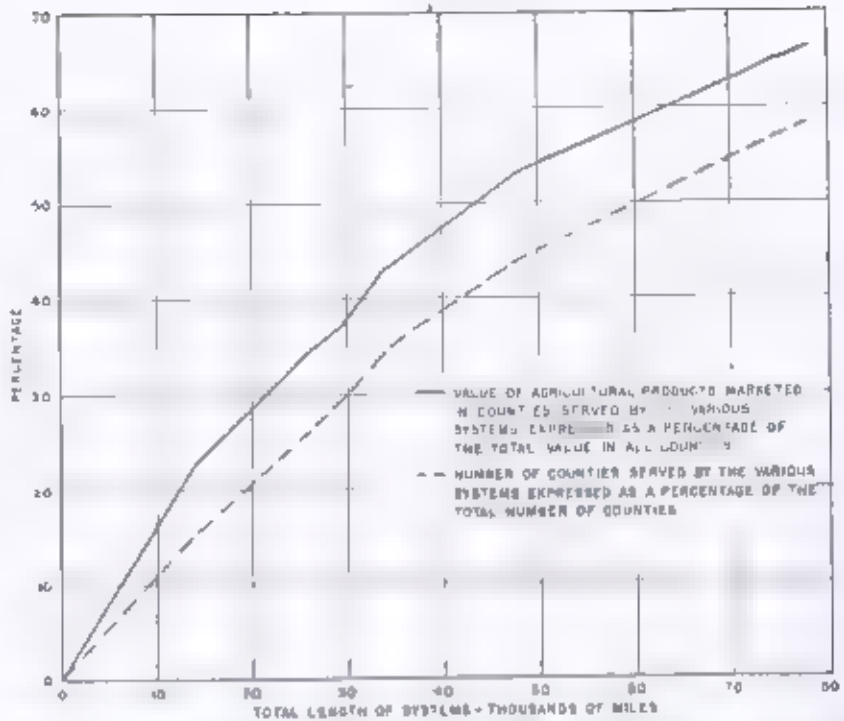

FIGURE 11.—The number of counties traversed, the value of agricultural products marketed in those counties, and the value of marketed agricultural products in counties traversed per unit of mileage in the various systems of interregional highways. The total value of marketed agricultural products in the region of study is also shown.

The geographic relationship of the recommended system to areas of high per-acre value in marketed crop production is shown in figure 9. The general types of principal farm production in areas traversed by the system are shown on the map, figure 10.

Although in comparison with the other systems investigated the recommended system does not afford so pronounced an advantage in proximity of service to agricultural production as in service to manufacturing industry, figure 11 shows that it does closely approach the greatest service to agriculture obtained by any of the systems. This advantage is indicated by the spread between the curves of value of agricultural products marketed and of number of counties traversed, reaches a maximum in the 48,300-mile system, but is nearly as great in the recommended system. Nearly all of the advantage accumulated in the 48,300-mile system, however, is contributed by routes which are also included in the recommended system.

Location in relation to situs of motor vehicle ownership.—Cities of 10,000 or more population located directly on the recommended system were the places of ownership in 1941 of 13,932,788 registered motor vehicles. Vehicles registered in the same year by other owners resident in counties traversed by the system numbered 8,180,819. The total of all motor vehicles registered by owners resident in counties traversed by the system amounted, therefore, to 22,113,607. This is 68.7 percent of the total 1941 registration of motor vehicles.

FIGURE 2 The recommended interregional system in relation to density of motor vehicle ownership per square mile and 10,000 population.

FIGURE 13 The recommended interregional system in relation to density of motor vehicle ownership per square mile.

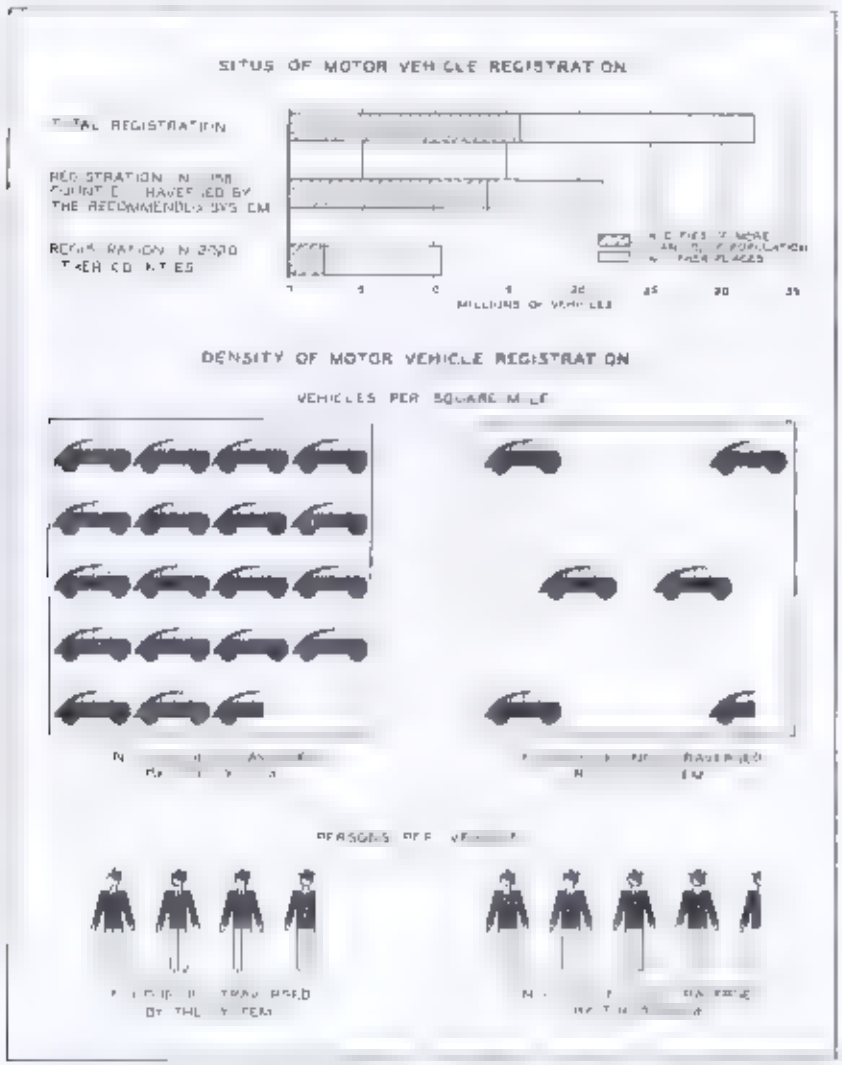

FIGURE 4.—Graphs show as the situs registration of motor vehicles in cities of more than 50,000 population and in counties traversed by the recommended system, and the density of registration in counties traversed by the system in comparison with the density in other counties.

In counties traversed by the system the density of motor-vehicle ownership in 1941 was 18.7 per square mile and 1 for each 3.9 persons. In all other counties the density was 5.5 per square mile and 1 for each 4.5 persons. These facts, shown graphically in figures 12, 13, and 14, give further evidence of the appropriate choice of routes included in the system. Table 7, which shows the same relations by geographic regions, indicates that the choice is similarly appropriate in all regions.

TABLE 7.—Motor registration and areas of motor vehicle ownership in 1941 in relation to the location of the recommended interregional highway system, by regions

Region	Motor vehicles registered in counties traversed by the system	Motor vehicles registered in counties not traversed by the system	Density of motor vehicle ownership: Vehicles per square mile — in counties traversed by the system	Density of motor vehicle ownership: Vehicles per square mile — in counties not traversed by the system	Density of motor vehicle ownership: Persons per vehicle — in counties traversed by the system	Density of motor vehicle ownership: Persons per vehicle — in counties not traversed by the system
United States						
New England						
Maine						
New Hampshire						
Vermont						
Massachusetts						
Rhode Island						
Connecticut						
Middle Atlantic						
New York						
New Jersey						
Pennsylvania						
East North Central						
Ohio						
Indiana						
Illinois						
Michigan						
Wisconsin						
West North Central						
Minnesota						
Iowa						
Missouri						
North Dakota						
South Dakota						
Nebraska						
Kansas						

TABLE 7.—*Data concerning the areas, motor vehicle use, and density of population in relation to the location of the recommended interregional system by regions and States*

Region	Area	Population	Motor vehicle registration	Motor vehicle travel	Density of motor vehicle ownership	
					Vehicles per square mile	Persons per vehicle
South Atlantic	283,308	21,336,225	4,603,370	71,300,000	16.2	4.6
Delaware	2,057	318,085	181,409	2,100,000	88.2	1.8
District of Columbia	61	763,956	432,344	4,000,000	7,085.2	1.8
Maryland	10,577	2,343,001	1,000,000	14,000,000	94.5	2.3
Virginia	40,815	3,318,680	1,000,000	14,000,000	24.5	3.3
West Virginia	24,181	1,901,974	787,000	6,000,000	32.5	2.4
North Carolina	52,426	4,556,155	341,000	5,000,000	65.0	2.9
South Carolina	30,495	2,117,027	283,551	3,000,000	9.3	7.5
Georgia	58,876	3,444,578	316,249	5,000,000	5.4	10.9
Florida	58,560	2,772,749	861,884	14,000,000	14.7	3.2
East South Central	178,240	12,700,000	3,000,000	40,000,000	16.8	4.2
Kentucky	40,395	3,038,156	1,000,000	10,000,000	24.8	3.0
Tennessee	42,022	3,567,089	1,000,000	12,000,000	23.8	3.6
Alabama	51,609	3,061,743	1,000,000	12,000,000	19.4	3.1
Mississippi	46,362	2,178,141	1,000,000	6,000,000	21.6	2.2
West South Central	262,398	14,537,000	4,000,000	50,000,000	15.2	3.6
Arkansas	53,045	1,909,511	1,000,000	8,000,000	18.9	1.9
Louisiana	48,523	3,257,022	1,000,000	10,000,000	20.6	3.3
Oklahoma	69,919	2,396,040	1,000,000	8,000,000	14.3	2.4
Texas	267,339	6,954,427	1,000,000	24,000,000	3.7	6.9
Mountain	1,150,309	5,074,998	1,000,000	13,000,000	0.9	5.1
Montana	147,138	591,024	1,000,000	2,000,000	6.8	2.0
Idaho	83,354	588,637	1,000,000	2,000,000	12.0	2.0
Wyoming	97,914	330,066	1,000,000	1,000,000	10.2	3.0
Colorado	104,247	1,035,791	1,000,000	5,000,000	9.6	4.8
New Mexico	121,666	681,187	1,000,000	2,000,000	8.2	2.9
Arizona	113,909	1,302,161	1,000,000	4,000,000	8.8	4.0
Utah	84,916	769,894	1,000,000	3,000,000	11.8	3.9
Nevada	110,540	110,014	1,000,000	1,000,000	9.0	9.1
Pacific	1,014,943	10,342,000	3,000,000	40,000,000	2.9	13.3
Washington	68,192	2,853,214	1,000,000	10,000,000	14.7	2.9
Oregon	96,981	1,768,687	1,000,000	6,000,000	10.3	5.7
California	158,693	10,586,223	6,521,914	147,300,000	37.5	2.3

Location in relation to areas of large post-war employment release.—In his letter to the Federal Works Administrator the President indicated his expectation that in the construction of an interregional highway system it would be possible to utilize some of the manpower and industrial capacity available at the close of the war. If such utilization is to be encouraged, a close relation is desirable between the location of the interregional routes and the principal places at which the release of war-occupied labor is to be expected.

Such correspondence in location would be advantageous, notwithstanding that the labor requirements and dispersion of war industries have caused an extensive migration of workers from their former communities to the places where they are now employed and where they will lose that employment when the war ends. The return of a peacetime economy may necessitate another and possibly reverse migration or at least a redistribution of the avoidable worker population. But it will be expedient to avoid if possible a precipitate rush from the war industry centers. At least temporary employment for considerable numbers of the workers that will be released should be provided in the general vicinity of their present jobs.

The routes of the recommended interregional system, particularly those that will stand at the close of the war in most immediate need of major improvement, are well located to supply the construction employment the President expects.

As indicated by the map, figure 15, remarkable correlation exists between the location of routes of the recommended system and the areas of greatest wartime employment increase. As it is to be expected that workers released by the cessation of war production will generally be most numerous where employment has increased most during the war, this map gives convincing evidence of the fortunate location of the recommended interregional routes for the post-war absorption of workers in a highway construction program. This result is especially [illegible] as those best fitted to meet the most important highway traffic requirements.

Location of the interregional system in relation to the strategic network.—War traffic on the highways—that to, from, and between the points of particular war activity concentration and between these points and the ports of embarkation—is moving in heavy volumes over roads conditioned for normal peacetime travel, and mainly over routes of the strategic highway network of principal routes of military importance approved by the Secretary of War as revised May 15 1941. (See fig. 16.)

With [illegible] the limitations of its total extent, the recommended interregional system conforms closely to this strategic network.

As we now clearly see, the significance of the strategic network in such a total war as that in which the Nation is at present engaged must be interpreted in terms of the carefully precise descriptive title applied to it by the War Department. It consists of not all but only the principal traffic routes of military importance. In the present war a very large part of the whole highway system of the Nation is bearing a substantial share of the burden of war, but we are finding that in general the routes of the strategic network were well chosen as the principal routes

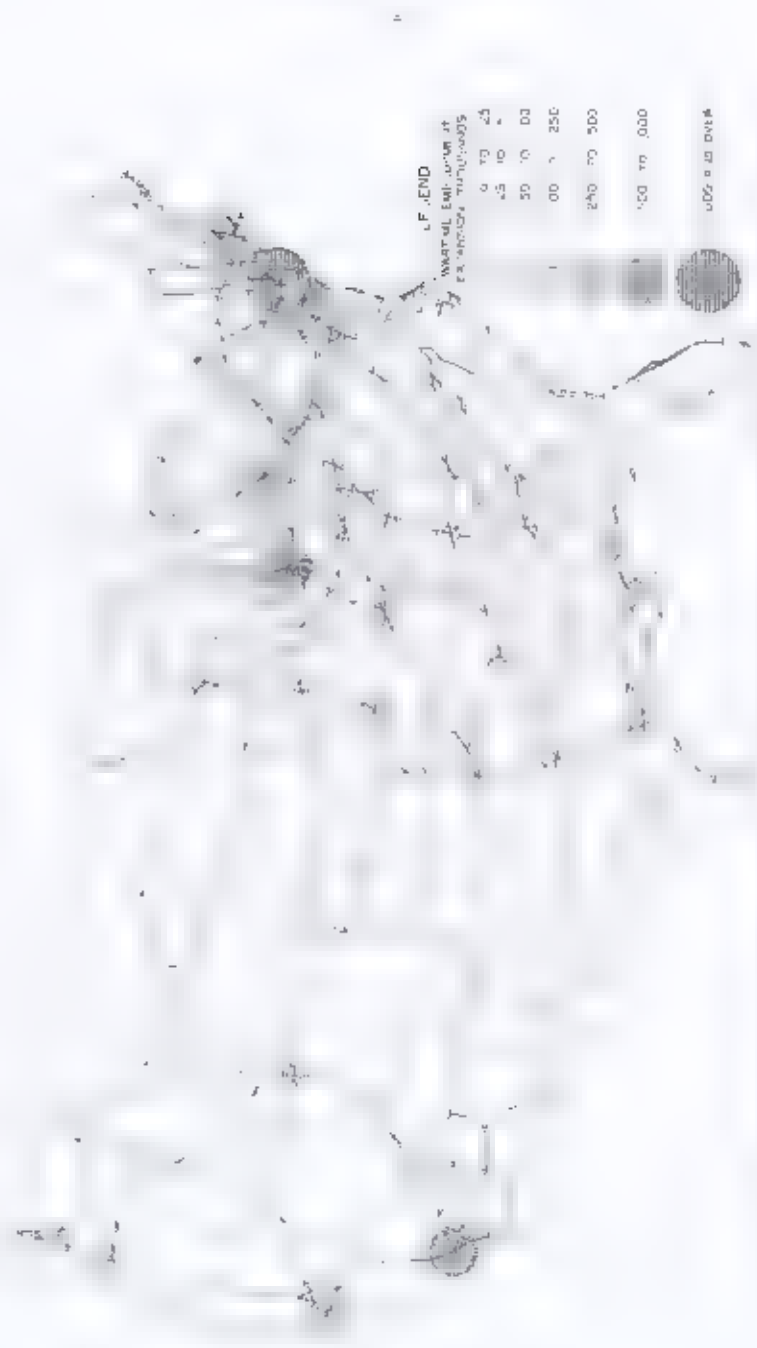

FIGURE 15.—The recommended interregional highway system in relation to areas of large increase in employment, March

FIGURE 16.—Relation of the recommended interregional system to the strategic network of principal traffic routes of military importance approved by the Secretary of War as revised May 15, 1941

In the same sense, the recommended interregional routes may be termed the more significant of the designated principal routes.

Location in relation to military and naval establishments and war industry.—The most urgent highway improvements during the war have been needed on roads and streets providing local access to military and naval establishments and important war industry sites. As accurately forecast by the report of the Public Roads Administration in 1941,[4] these improvements have been necessary because so many of the war establishments and industries have been located not on the principal arteries of peacetime travel but on roads or streets which have previously carried only light traffic.

The fact that these relatively short and local improvements have constituted so large a part of wartime highway construction does not indicate, however, that only these roads are of importance to the war effort. Rather, it means that except for these local approaches, the highway system of the Nation has proved to be reasonably fit to discharge its war duties, without special readying improvement.

That the routes of the recommended interregional system must bear a very large share of the longer highway movement to and from the military and naval establishments is indicated by the close proximity of the great majority of these establishments to the recommended routes. (See fig. 17.)

A similar conclusion with reference to service to war industries is justified by the comparative locations of the recommended routes and the points of early concentration of primary war industry and of industries served by roads improved during the war as access road projects. (See figs. 18 and 19.) It must be borne in mind that the industrial locations particularly referred to are only a few of the many now involved in direct production for the war and of the even larger number concerned in the many and varied industrial contributions to the total essential war economy. To represent the location of the recommended system in relation to the distribution of total-war industry would doubtless give a result little different from the indications of figure 7, which mirrors the distribution of normal peacetime industrial activity.

Location of the interregional system in relation to routes of heaviest traffic. Connecting the largest cities of the country and the larger cities of each geographic region, passing generally through the most populous belts of rural and small-town population, joining centers in which a high percentage of the Nation's manufacturing activity is concentrated, traversing generally the most productive agricultural lands, and tapping the centers and areas of densest motor-vehicle ownership, it is naturally to be expected that the recommended system will accommodate with the heaviest lines of highway traffic flow and serve in the aggregate a share of the total highway movement far in excess of its proportion of the total highway mileage.

[4] Highways for the National Defense, Report to the Administrator, Federal Works Agency, John M. Carmody, the Public Roads Administration, February 1941

FIGURE 7.—The recommended interregional system in relation to the location of prime air military and naval establishments

FIGURE 8. The recommended interregional system in relation to areas of early concentration of primary war industry.

FIGURE 19.—The recommended interregional system in relation to industrial sites served by roads improved as access road projects

That this expectation is fully borne out by the facts is shown by the traffic map, figure 20. Here the 1940 traffic on existing roads closely conforming to the recommended system is compared with the traffic on other roads included in the numbered United States highway system. In examining this map it must be remembered that all of the roads represented have been selected from the total highway system many times as large because of their special importance as traffic carriers. In other words, on this map the traffic of the recommended system is compared not with the general level of rural highway traffic, but with the traffic of other roads which themselves rank among the most heavily traveled highways in their respective sections of the country.

It will be observed at once that some heavily traveled sections of highway are not included in the recommended system. It will be seen, however, that with few exceptions, the recommended routes are the most heavily traveled in their respective regions. In the exceptional cases the choice of the recommended route has been determined by the criterion of most direct connection between major cities. To include in the system all routes locally approximating the volume of traffic served by the recommended routes, would substantially increase the mileage of the system and generally result in a duplication of routes serving the same general areas and travel objectives.

In some instances traffic of the longer range is now divided between an existing road conforming most closely to the recommended interregional route and another parallel route of substantially equal directness and degree of improvement. There are also instances in which an existing road closely follows the recommended route, but because of a local inferiority in either directness or condition, carries a smaller traffic than an alternate road.

The committee wishes to emphasize that its recommendation applies to general routes and not to special highways, notwithstanding the fact that the various maps presented in this report show the recommended routes as following the general location of selected existing highways.

In a detailed location of the routes of the system, the exact location at all points will be a problem for local reconnaissance study. The eventual final selection of line may, therefore, more closely approximate existing roads other than those followed in the general-system maps herein presented. To a considerable extent the proper development of the recommended system will result in the location of the recommended routes locally, on new lines conforming to no existing highway.

The comparison made possible by figure 20 is therefore to be considered as only a very general one.

Of the 29,450 miles of rural roads approximating the location of rural sections of the recommended system traffic counts made by the highway planning surveys in 1941 show that 6,056 miles, or 20.6 percent of the total, carried traffic that year averaging less than 1,000 vehicles daily. On 9,576 miles, or 32.5 percent, the daily traffic averaged between 1,000 and 2,000 vehicles. A total of 6,104 miles, or 20.7 percent, served traffic averaging between 2,000 and 3,000 vehicles daily; 7,182 miles, or 24.4 percent, carried traffic between 3,000 and 10,000 vehicles per day, and only 532 miles, or less than 2 percent of the total, carried an average daily traffic of

10,000 or more vehicles. The average traffic carried by all rural roads conforming closely to the system was 2,660 vehicles daily, and the total traffic movement, 78,208,300 vehicle-miles daily. The latter was 16.79 percent of the 465,753,000 daily vehicle-miles served by all rural roads in 1941. No similarly exact data are available to show the traffic served by existing city streets approximating the location of routes of the system, and were such facts available they would be of little significance as a basis for an estimate of the traffic that would be served by more adequate facilities.

In estimating the probable traffic use of the recommended system, the committee has made due allowance for shifts of existing traffic flow that would be induced by a preferential improvement of the recommended routes. Its estimate is that the system, as it probably would be constructed, would represent only about 1 percent of the total mileage of rural roads and streets, but would serve at least 20 percent of the total vehicle-mileage generated on all roads and streets.

Location in relation to principal topographic features.—The location of the recommended routes has been influenced in remarkably few places solely by consideration of topography. A knowledge of the general topography of the country is nevertheless essential to a full [illegible] of reasons for the varying sizes of interstate between the meshes of the system in different parts of the country and for the few places in which apparent indirection of the lines of the system would otherwise be unaccountable. The overlay of the recommended interregional routes on a physiographic chart of the United States, reproduced as figure 21, indicates clearly the effect of the conformation of the land and of the courses of principal rivers in influencing the location of the routes.

Determinants in Selection of Interregional System

In selecting the routes to comprise the system and in determining the extent of the system to be recommended, the primary purpose was to select routes forming an integrated system of reasonably limited [illegible] would join the principal centers of population and industry in each geographic region with centers of similar relative importance in other geographic regions, by lines as direct as practicable.

The principal determinants in this selection were, therefore, the interconnection of the larger cities in all regions, accommodation of short-run traffic in and about lesser centers insofar as practicable, and creation of a system of optimum extent and maximum utilization.

Interconnection of Larger Cities

As proof of the importance of interconnecting the major cities, evidence is here presented which indicates that nearly 90 percent of the traffic moving on main highways has either or both its origin and destination in cities, that traffic steadily increases with increased proximity to cities, that on transcity connections of main routes traffic mounts to volumes far greater than the general levels on rural sections, and that the heavily traveled sections of the proposed interregional system lie mostly within relatively narrow zones of traffic influence about cities of 10,000 or more population.

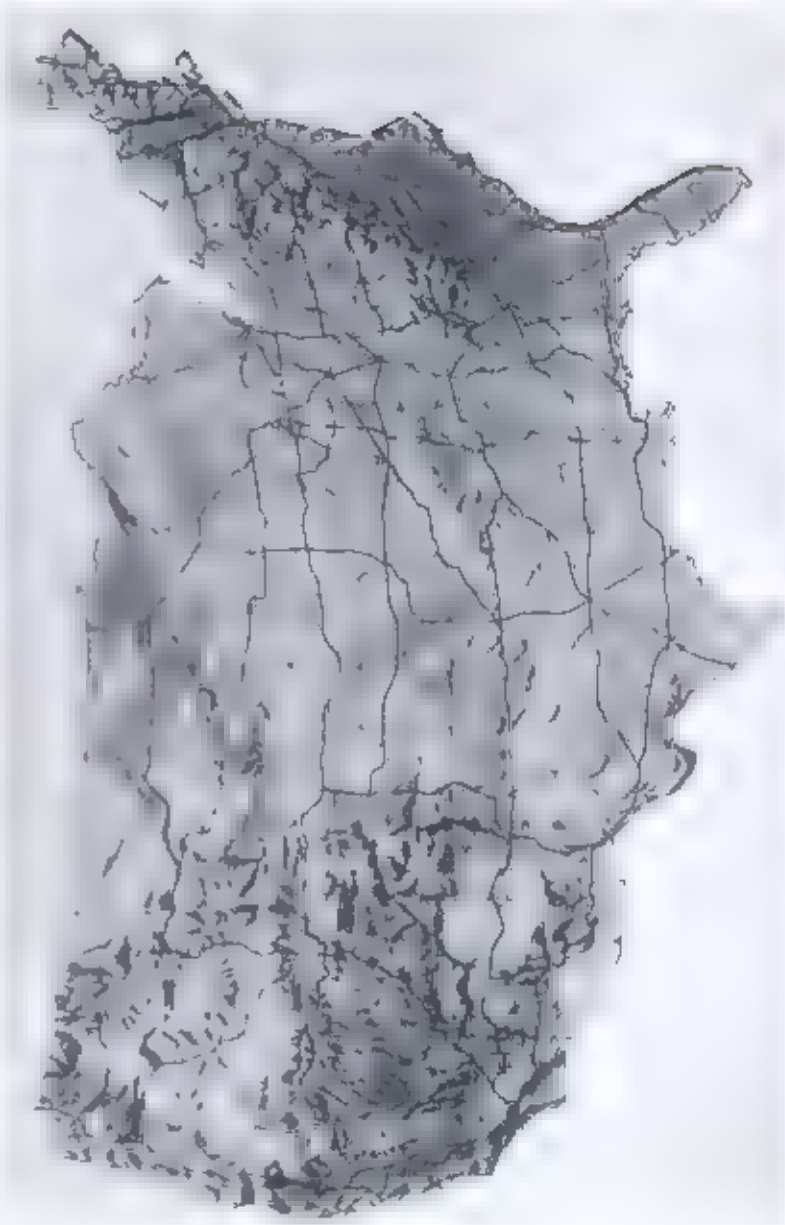

FIGURE 21.—The recommended interregional system in relation to principal topographic features of the United States. Relief map by Howard B. Coulter.

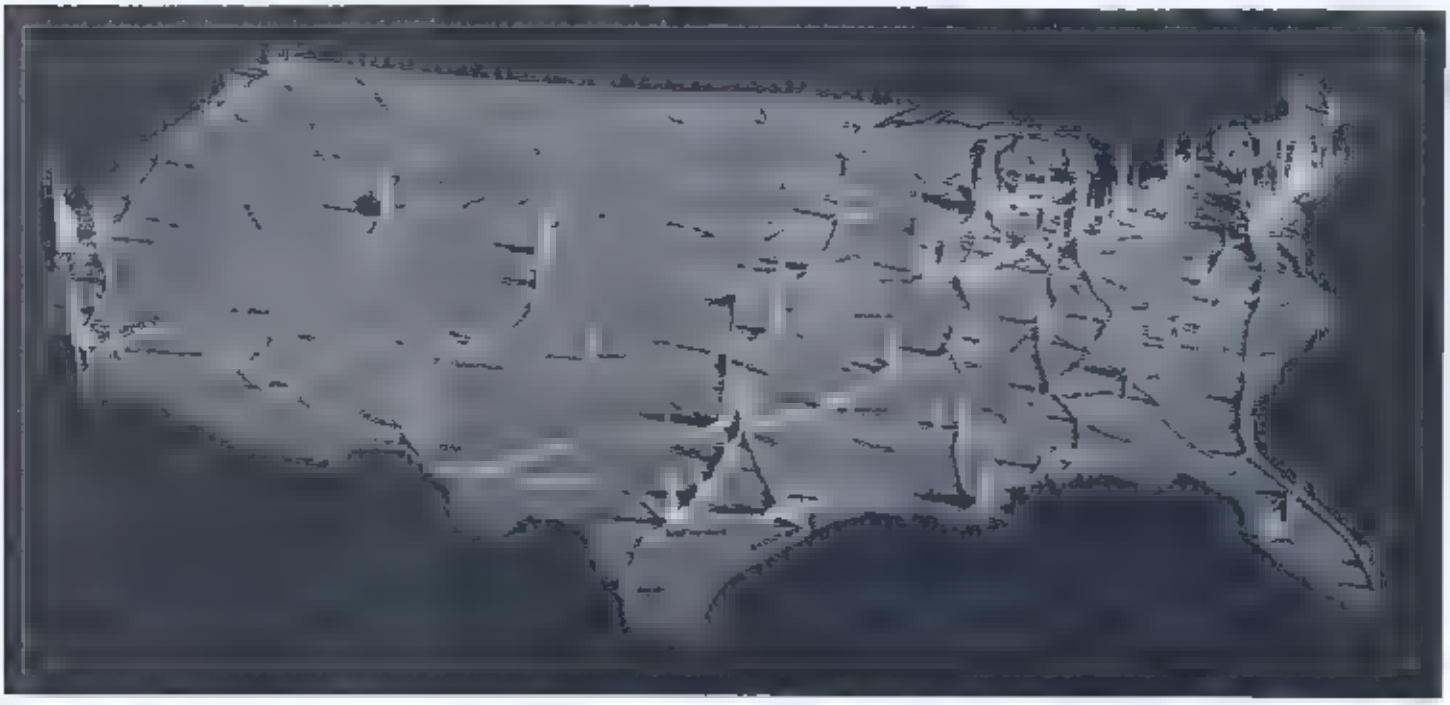

FIGURE 22. Relief traffic map of the recommended interregional system. The height of the traffic bands indicates approximately the average density of traffic to be expected on the several sections of the routes traversing the cities. The running spines at the principal cities indicate the great increases of traffic to be expected on sections of the routes traversing the cities.

Cities important as origin and destination of traffic. Table 8 presents an analysis of available data on the urban or rural termini of traffic observed on main highways. The data were obtained by the highway planning surveys of typical States in seven regions. The analysis shows that on the average 49.6 percent of all traffic observed was moving from one city to another, and 36.6 percent was bound either from a city origin to a rural destination or from a rural origin to a city destination. Thus nearly seven-eighths of the main highway traffic in these representative States is related in some manner to cities. Either they are its origin or its destination or both. Only 13.8 percent both begins and ends at rural points and a portion of this movement undoubtedly passes through urban communities en route.

TABLE 8.—*Analysis of the origins and destinations of traffic on main highways as shown by highway planning survey data, in one State in each of seven geographic regions*

Region and State	Percentage of all traffic having various origins and destinations		
	Origin [illegible] both [illegible]	Origin [illegible] rural [illegible]	Origin [illegible] both rural [illegible]
	Percent	*Percent*	*Percent*
All regions, average	49.6	36.6	13.8
New England: New Hampshire	50.1	46	15.0
[illegible]	67.5	30.7	1.8
[illegible]	41	37.0	22.0
[illegible]	60.5	25.0	13.8
[illegible]	67.8	24.4	7.8
[illegible]	41.7	56	32.2
[illegible]	23.4	46.6	30.0

The facts presented in table 8 relate to all main-highway traffic of both long and short range, including passenger cars, busses and trucks. The data of the planning surveys do not permit a particular examination in this respect of the long-range traffic of all classes of vehicles.

For the States represented in table 8, however, data on motor-truck traffic are available which permit a classification of the movement according to a general indication of length of trip as intrastate, interstate, and transstate, and a further analysis of each of these classes according to the percentages of each that have their origins or destinations or both in cities.

The term "interstate" is used to refer to traffic bound to or from the State of observation from or to another State. The term "transstate" refers to traffic found to be moving entirely across the State of observation between origins and destinations in other States. The term "intrastate" is used in its ordinary sense.

The classification thus accomplishes an analysis of the total movement approximately into patterns of long, shorter, and shortest ranges. The analysis is not exact with respect to the relative lengths of trip, especially as indicated by the intrastate and interstate fractions. Interstate movements may be, and are in many cases, short movements over a State line. Intrastate movements, though confined entirely to a single State, may be relatively long movements.

All the available data show however that the average trip length is least for the intrastate movement greater for the interstate movement and greatest for the transstate movement While therefore, the three classes are based specifically upon the number of States involved in the traffic movements they also represent approximately and on the average three ranges of trip length from short to long

Data of this sort are presented in table 9 for the same regions that are represented in the case of table 8 These additional data show clearly that for truck traffic as well the percentage of the main highway movement originating in or destined to cities increases with the increasing range of movement For the seven States and regions represented in the table cities are involved as the origin or destination of such as 87.0 percent of the intrastate or short range movement 66.3 percent of the interstate or longer range movement and 96.7 percent of the transstate or longest range movement

TABLE 9.—*Classification of motortruck traffic on main highways as intrastate, interstate and transstate and percentages of each class originating in or destined to cities or other points of interest in the State or each of seven geographic regions*

Region and State	Percentage of truck traffic by classes of movement			Percentage of each class originating in or destined to cities		
	Intrastate	Interstate	Transstate	Intrastate	Interstate	Transstate
All regions, average	Percent 45	Percent 18	Percent 37	Percent 87.0	Percent 66.3	Percent 96.7
New England: New Hampshire	74.4	25	12.0	80	92.9	93.0
Mid-North Central: Nebraska	5	21.6	8.4	2.0	38.5	90.1
South Atlantic: West Virginia		20.6	7.8	82.0	93.5	94.0
East South Central: Tennessee	91.5	6.3	4.2	85	95.4	96.5
Mountain: Utah	6.4	9	4.8	77.9	91.0	94.7
Pacific: Washington	57	4	3	90.8	95.4	96.4
	66.6	5	3	89.1	95.2	96.6

Although data similar to these for motortrucks in table 9 are not available for passenger cars or for the entire traffic it is probable that relations similar to those presented for trucks exist also in the passenger-car and total traffic If this is true and the Committee believes that it is true the Nation's long range highway traffic and especially the interregional traffic is in very large part a traffic moving between cities or at least a traffic that has either its origins or its destinations for the most part in cities.

Traffic volumes at city approaches.—A glance at the traffic map, figure 20, will show how the traffic volume bands of the main rural roads represented in reasonable width as they approach the location of cities naturally increase in width with increasing proximity to the cities In all cases the traffic volumes represented on this map are those observed at points on the highways outside city limits. In no case do the traffic bands represent the volume of traffic on extensions of the routes within cities, and in many cases the greatest traffic represented is that observed at points some distance—often several miles outside the city limits. Particularly at the larger cities it has been found impossible to represent by a convenient scale on any two-dimensional map the volume of traffic observed at points immediately adjacent to the cities without causing such overlapping of the bands for several highways as to create an undesirable graphical confusion, and in such cases the near-city volumes are not represented at all in figure 20

Traffic peaks at transcity connections.—To indicate the further increase in traffic volume that occurs when the highways pass into and through cities between the nearest points of recorded observation represented on the two-dimensional traffic map, figure 22 is included. By means of a vertical projection of the traffic bands figure 22 shows for the recommended interregional system only, what is believed to be a reasonable estimate of the relative magnitudes of traffic volume on all rural sections of the system and on intracity sections at a number of the larger cities.

As suggested by this very approximate picturization traffic on sections of the routes traversing the cities mounts rapidly to volumes that far surpass the general levels of volume on the rural portions of the system. Moreover, it will be seen from both figure 20 and figure 22 that these rapid increases begin at points comparatively close to the cities.

The peaks represented on the three-dimensional traffic map figure 22 in many cases exceed the more than informal guesses but their sharpness is exaggerated by the inevitable compression of horizontal scale. That they do not, in fact, exaggerate the relative traffic volumes of the routes within and without the cities, is shown by the comparisons based upon available data for several cities of different sizes, shown in figure 23

Urban zones of traffic influence.—A study has been made of the available data on traffic flow in the vicinity of all cities of 10,000 or more population directly connected by the recommended system, with the object of determining the approximate distances from each city at which the more rapid increase of traffic volume begins These distances have been measured as radial distances from centers located at the heart of the central business areas of the respective cities. They define, for each city, a circular area which may be described as the city's zone of local traffic influence.

It is found that the radii of these zones tend to increase with the population of the cities By averaging the radii for all cities of each of several population ranges the following determination was made of what may be called approximate normal radii of the zones of local traffic influence for cities of different sizes.

City population	Radius of zone of traffic influence (miles)
3,000,000 and more	35
1,000,000 to 3,000,000	30
500,000 to 1,000,000	25
250,000 to 500,000	20
100,000 to 250,000	15
50,000 to 100,000	12
25,000 to 50,000	9
10,000 to 25,000	6

Within these zones of local traffic influence around the 587 cities of 10,000 or more population, are 8,141 miles of the recommended interregional system, or 24 percent of the entire system. Of the total mileage within these zones, transcity streets in the cities of 10,000 or

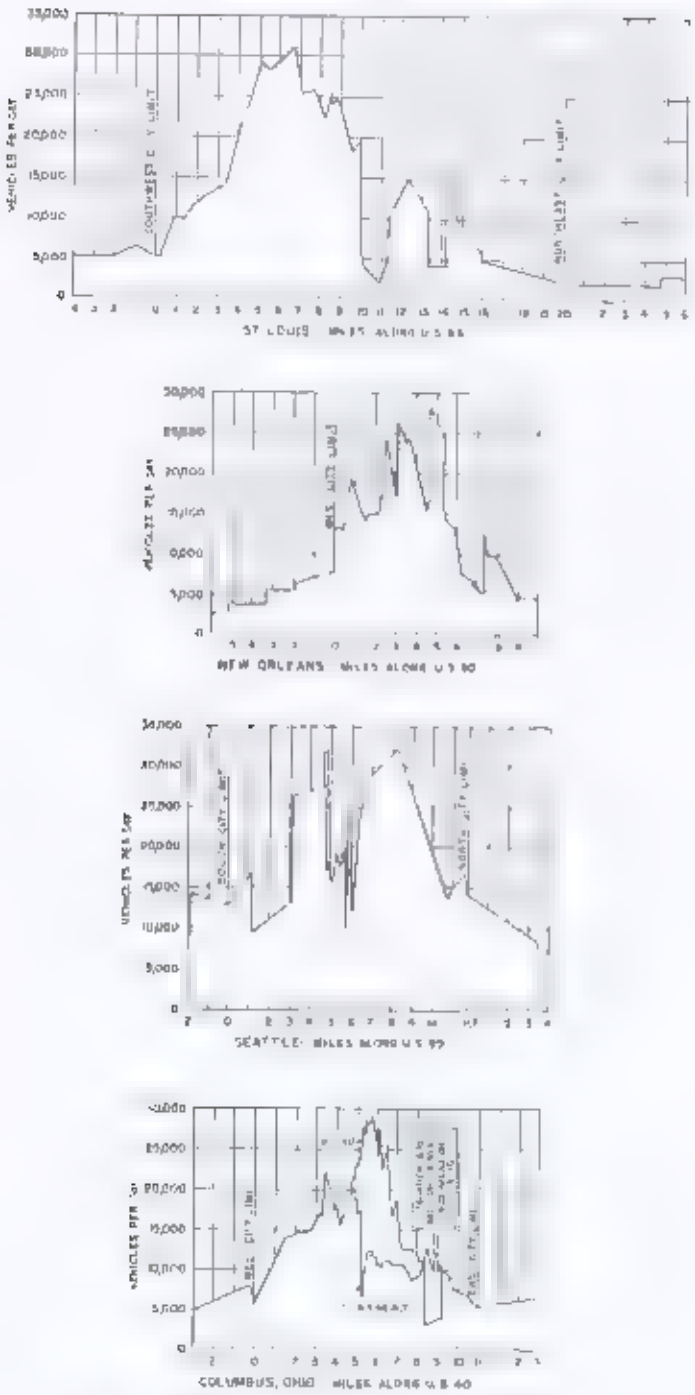

FIGURE 21. Traffic profiles of routes conforming approximately to routes of the recommended interregional system through representative cities.

more account for 2,123 miles, and similar streets in smaller incorporated places add 492 miles.

The balance—5,526 miles or nearly 68 percent of the 8,141 mile total—is on rural sections of the interregional system, and includes all rural sections of the system that serve traffic in excess of an average of 3,000 vehicles per day. This high volume mileage totals 542 percent. The rural mileage within the zones of city influence also includes 3,558 miles or 48.3 percent of the 7,363 miles of rural sections that carry traffic averaging between 3,000 and 10,000 vehicles per day.

These 2 rural mileages—532 miles and 3,558 miles—comprise 74 percent of the total rural mileage within the zones of influence of cities of 10,000 or more population, and serve traffic well above the average daily volume for all rural sections of the system.

The remaining 26 percent of the rural mileage within these zones, or 1,436 miles, carries traffic averaging less than 3,000 vehicles per day.

Nearly three-fourths of this latter mileage, however, carries traffic in excess of the approximately 2,000 vehicles per day average for the rural system as a whole.

The more heavily traveled of the rural sections that lie outside the zones of traffic influence of cities of 10,000 or more population, total 3,624 miles and carry traffic averaging 1,800 vehicles per day. By far the greater part of the rural mileage within these zones—a total of 20,000 miles—carries traffic averaging less than 1,000 vehicles per day. The average for the entire 24,500 miles is only 1,531 vehicles per day.

Most of these facts are tabulated in table 10 for the entire United States, and in tables 11 and 12 by geographic regions.

TABLE 10. *Classification of mileage of the recommended interregional system for the United States as a whole*

Principal classification	Length of sections, in miles					
	Within incorporated places		Outside incorporated places			
	10,000 or more population	Less than 10,000 population	Traffic exceeding 10,000 vehicles per day in 1941	Traffic between 3,000 and 10,000 vehicles per day in 1941	Traffic less than 3,000 vehicles per day in 1941	Total
Within zones of influence of cities of 10,000 or more population	2,123	492	532	3,558	1,436	8,141
Within zones of influence of cities of less than 10,000 population		1,955		3,624	20,800	26,779
United States	2,123	2,447	532	7,182	21,236	33,920

TABLE 11.—*Classification of mileage of the recommended interregional system falling within zones of local traffic influence of cities of 10,000 or more population, by geographic regions*

Geographic region	Length of sections, in miles					
	Within incorporated places	Outside incorporated places				
	10,000 or more population	Less than 10,000 population	Traffic exceeding 10,000 vehicles per day	Traffic between 3,000 and 10,000 vehicles per day	Traffic less than 3,000 vehicles per day	Total
New England	65	15	102	274	14	470
Middle Atlantic	301	4	0	555	37	897
East North Central	509	7	158	672	75	1,421
West North Central	91	20	5	244	230	590
South Atlantic	284	24	74	369	212	963
East South Central	71	22	-	308	10	411
West South Central	91	21	6	450	87	655
Mountain	10	36	3	108	217	374
Pacific	376	74	165	280	84	959
United States	2,000	450	513	3,558	1,436	7,957

TABLE 12.—*Classification of mileage of the recommended interregional system falling within zones of local traffic influence of cities of 10,000 or more population, by geographic regions*

Geographic region	Length of sections, in miles					
	Within incorporated places	Outside incorporated places				
	10,000 or more population	Less than 10,000 population	Traffic exceeding 10,000 vehicles per day	Traffic between 3,000 and 10,000 vehicles per day	Traffic less than 3,000 vehicles per day	Total
New England	81		147	663		891
Middle Atlantic	295		479	636		1,410
East North Central	324		981	1,307		2,612
West North Central	259		211	1,115		1,585
South Atlantic	326		436	2,149		2,911
East South Central	216		583	2,179		2,978
West South Central	418		417	1,519		2,354
Mountain	215		46	1,107		1,368
Pacific	72		240	870		1,182
United States	1,955		3,674	20,300		25,772

It is seen that a large part of the more heavily traveled mileage of the system and all of the most heavily traveled sections lie within relatively narrow zones encompassing about the cities of 10,000 or more population. As a further generalization, it may be added that most of the remaining more heavily traveled mileage is located closely contiguous to such zones. Obviously the heavier travel of these sections is generated largely by local movements in and out of the central cities.

Thus as the evidence on the preceding pages shows, cities are of very great importance in the movement of most interregional and long-range traffic. It was on this fact as well as on its general knowledge that the most concentrated masses of population and industry are located in the cities, that the Committee determined to base its system of routes primarily upon the principle of direct connection between cities of important cities.

ACCOMMODATION OF SHORT RUN TRAFFIC MOVEMENTS

As important as the interconnection of cities is, however, equal directness of connection between the largest centers was not needed. Yet highway traffic is a composition of long range and short range movement and the highway planning surveys have shown that the latter is the predominant element on rural roads. Normally for example about 85 percent of all trips are for less than 20 miles, and only about 5 percent for more than 50 miles.

In the selection of routes therefore the Committee has deemed it desirable to deviate from nearly direct lines of connection between the larger regional centers in order to connect on routes as many as practicable of the smaller urban centers.

Large and small are relative terms however. The question upon which the Committee had to reach a decision was that of the general order of cities to be considered as primary points of connection. This decision would determine the extent of the system secured.

In applying the terms "large" and "small" to the problem in hand, the Committee has considered both the population and the commercial importance of the cities. It has sought by judgment to determine the cities of primary connection and also the extent of desirable deviation from direct connection between these primary points in order to join in the system, urban communities of lesser importance.

MAXIMUM UTILIZATION

To connect all communities classified as urban would require inclusion in the system of a large part of the Nation's 3,000,000-mile rural road system. Such a system would serve a very large part of the total highway traffic but its average intensity of usage would be low by reason of the presence of much lightly traveled mileage. Obviously it would not be a more extensive system than any that could properly be described as a major interregional system.

To go to the other extreme it would be possible to select a system that would connect only or mainly the very largest cities of the country. It might be possible to accomplish this with a few transcontinental highways in each direction though the connection would be indirect except between cities joined by the same route and such a system would serve conveniently and fully only a very small part of the highway traffic of longer range. It would miss connection with many of the larger cities in its direct courses between the very largest cities. It would therefore traverse long distances particularly in the West where there would be little traffic to serve. Hence the average intensity of usage of such a system would probably be less than that of a larger system that would reach more, even though smaller cities.

The Committee reasoned that somewhere between these two extremes, employing basically the principle of the interconnection of larger cities, it should be possible to select a system of optimum extent the average usage of which would reach a maximum of intensity Consequently as a whole the average daily traffic volume for such a system would be greater than that for any other system either more or less extensive.

The Committee determined to select a system approximating as nearly as practicable this optimum extent. This is observed to coincide by a sharp change in the rate of increase, each larger and smaller than the probable optimum, in the daily vehicle miles of travel against the mileage of systems. If selected data were plotted the curve would be formed the maximum degree of which representing the maximum daily traffic volume would correspond to an abscissa representing the extent of the optimum system.

Data for such analyses were available to the Committee in several states previously investigated by the Bureau of Public Roads. One of these studies was that relating to the system of 24,500 miles described in the report entitled "Toll Roads and Free Roads," transmitted to Congress by the President in 1939.[6] This system was regarded as very close to a system of minimum extent and therefore probably below the optimum. Another was the 37,000-mile system recommended by the Bureau of Public Roads in the same report. Still another was a suggested extension of the latter system totaling 29,000 miles, which was published several years ago in an article entitled "Planning the Interregional Highways."[7] A fourth was a 48,000-mile system on the basis of a system containing 78 500 rural sections. In these five systems the rural routes and cities are substantially confined to certain. Parallel routes in intermediate areas forgive from the progressive addition of routes. Each is shown on a separate map in appendix II figures 1 to 5, inclusive.

With respect to city connection the extremes of these systems range from the [illegible] connection between a number of cities of [illegible] population, a [illegible] of 50,000 or more population or the larger which connects directly a large percentage of all cities with population of 10,000 or more persons.

From data obtained by the highway planning surveys the total traffic service of each proposed route was credited to each of these five previously investigated systems was obtained in unity vehicle miles and the corresponding average daily traffic volumes were computed. These data together with the mileages of the systems are given in the upper section of table 13.

From these data the values for the mileage and average daily traffic of each of the five systems were taken and plotted as points on a system of rectangular coordinates as indicated by the outline dots in figure 24. These points were then connected in various ways by straight lines.

[6] Toll Roads and Free Roads. H. Doc. No. 272, 76th Cong., 1st sess.
[7] Planning the Interregional Highway System, by H. B. Hill, Public Roads, vol. 22, No. 4, June 1941, p. 69.

TABLE 13.—*Estimated urban, rural, and total mileage, total rural vehicle mileage, and average daily traffic volume on rural sections, for all systems studied including the recommended system*

Mileage of systems	Mileage of rural sections	Total rural vehicle mileage	Average daily traffic on rural sections
Total mileage			
Systems previously investigated	Miles	Vehicle miles	Vehicles
[illegible]	[illegible]	32,[illegible]00,000	9,540
[illegible]	[illegible]	50,300,000	2,540
[illegible]	[illegible]	60,[illegible]00,000	3,600
[illegible]	[illegible]	104,000,000	2,480
[illegible]	70,[illegible]30	180,300,000	2,140
Additional systems tentatively investigated			
[illegible]	31,350	80,681,000	2,380
Recommended system			
[illegible]	29,450	76,208,000	2,050

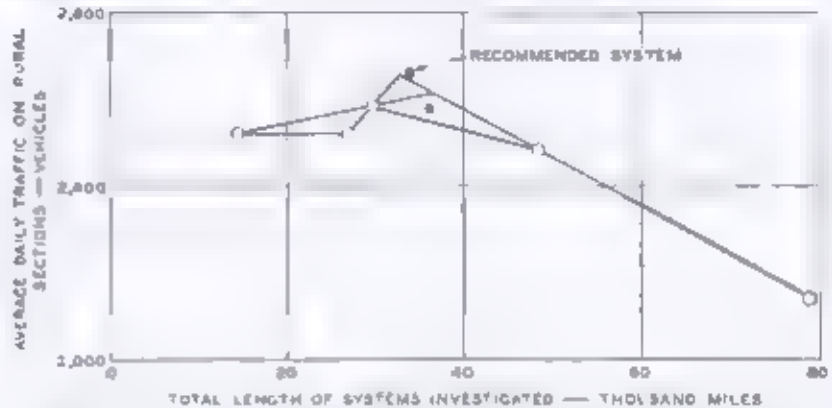

FIGURE 24.—Graph employed in refining Committee's selection of the interregional system.

From the resulting graph it was assumed that a maximum value of average daily traffic might have been obtained on the 29,300-mile system. If this value could be exceeded it was conjectured that a maximum value might be obtained by a properly selected system of either 36,000 or 37,000 miles approximately, the ranges represented by other intersections of the straight lines of the graph.

Accordingly, a 36,000-mile system was formed by adding to the routes included in the 29,300-mile system, certain routes designed to connect relatively important cities not reached by the smaller system and by eliminating a few of the less important routes. The resulting system is shown by the solid lines of figure 25, the heavier lines representing the added routes. The dotted lines in this figure represent the routes of the 29,300-mile system that were omitted from the larger system. As shown in the middle section of table 13, this 36,000-mile system proved to have an average daily traffic volume on its rural sections of 2,580 vehicles, slightly less than the value for the 29,300-mile system and also less than the value indicated by the 36,000-mile intersection point in the graph, as shown by the lower solid dot.

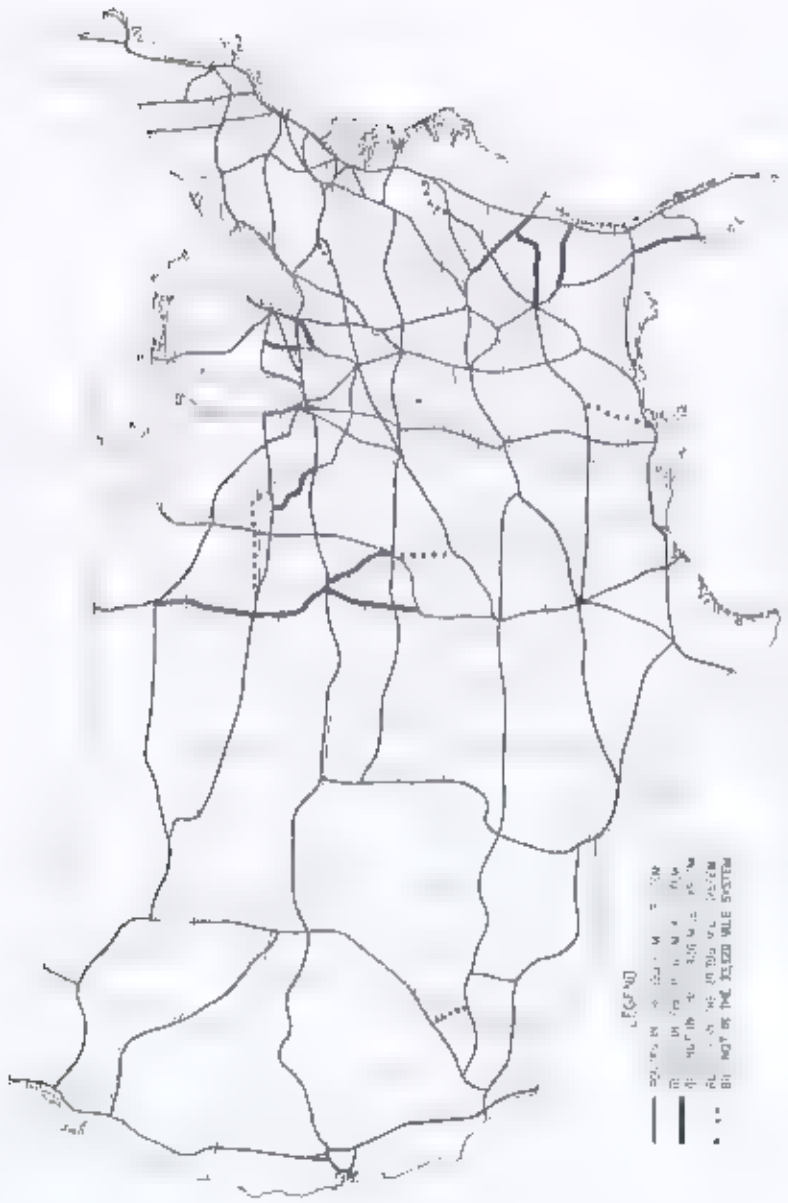

FIGURE 25.—The 36,000-mile additional system investigated by the committee.

It was now clear, however, that by the elimination of certain of the routes added to form the 36,000-mile system, the resulting 33,920-mile system, though smaller in extent, would carry a higher average traffic volume than had been attained in either the 29,300-mile or the 36,000-mile system. The routes eliminated were those connecting the smaller cities and serving the lighter traffic volumes. The average daily traffic volume of the resulting system was found to be 2,660 vehicles, as shown by the upper solid dot. This volume is greater than the traffic indicated even by the highest of the intersections in the graph—that representing a 33,000-mile system.

It is believed, therefore, that the 33,920-mile system, data for which are given in the lower section of table 33, is very close to the desired optimum system. As shown in figure 1, it is the system recommended by the Committee for adoption. Although in mileage the existing rural roads conforming to this system constitute only 0.99 percent of the country's total of 2,964,677 miles of rural roads, it is estimated that they served in 1941 16.79 percent of the total of 465,753,000 daily vehicle-miles of travel on all rural roads in that year.

Conclusions

Facts presented thus far on the interregional highway system clearly lead to the following conclusions:

1. The system, if it is to attract and serve a reasonably large proportion of the total highway movement, must connect as many of the larger cities of the country as its limited mileage will permit.

2. Whatever other facilities it may provide, the system must incorporate adequate routes leading directly into the larger cities, including at least most of the cities of 10,000 or more population.

3. Especially in the more densely populated sections of the country the general directness of the routes between larger cities should not be sacrificed for close approach to cities of substantially less than 10,000 population. Where these smaller cities lie reasonably near the path of direct routes, they may be adequately served by a skirting location of the main route. Such a location will generally be in the interest of the preponderant part of the traffic.

The recommended interregional system conforms generally to the principles enunciated in these conclusions.

Its 33,920-mile total extent includes 2,123 miles within the municipal limits of cities of 10,000 or more population. This is approximately the mileage required to provide a direct connection into the downtown area of these cities joined by the various routes. The mileage reported is measured along existing streets now serving the traffic in the capacity described, just as the reported mileage of rural sections of the routes is measured over existing highways conforming closely to the recommended interregional routes in rural areas. A desirable improvement of the system will alter these mileages both within the larger cities and in rural areas, generally by reduction.

Included also in the proposed total mileage of the recommended system are 2,347 miles within the limits of cities of less than 10,000 population. This also is measured along existing streets now carrying the trade stream intended to be served by the proposed interregional

routes. In some cases a desirable improvement of the system will do l less follow locations selected outs le of hese t es, thus decreasing to some extent the total mileage within municipal limits, but possibly tending to increase slightly the total reported mileage of the system.

The 33,920-mile total mileage reported does not include any allowance for alternate circumferential or distributing routes required at the larger cities for the dual purpose of bypassing through traffic and of distributing and assembling other traffic to and from the several quarters of the city. Although generally a relatively small part of the total through traffic would be interested with the growth or development of the city rest ts in a movement so large as to require circumferential routes in addition to the radially entering connections. These circumferential routes, an essential part of the interregional system, are discussed in some detail in a subsequent section of this report. Their proper location and mileage can be determined only by detailed study of the needs and conditions of each city involved. The Committee has, however, estimated that the aggregate extent of such desirable alternate and auxiliary routes will not exceed 5,000 miles. If added to the more definitely determined mileage of primary routes, this additional mileage, probably located largely within and partly without municipal limits, would increase the total extent of the recommended system to about 39,000 miles.

LOCATING THE INTERREGIONAL ROUTES IN URBAN AREAS

The location of interregional highways to serve the city as it is today, no matter what its condition may be, is a comparatively simple task.

Once constructed, however, the interregional highways would be relatively permanent. But cities cannot be said to have attained well organized and relatively permanent form.

Because of these two things—the permanency of the highways and the more or less planless form of the cities—the interregional routes must be so located as to conform to the future shape of the cities, insofar as this can be foreseen, as well as to the existing pattern of urban centers.

American cities of today are surprisingly uniform in their status and evolution, although no generalized description can ever adequately portray any one of them. The focal point of them all, however, is the central business district, which contains the large stores and office buildings and is often the cultural and civic center of the urban community. But this "downtown area" is cramped, crowded, and depreciated. Land values are often less than they were 20 years ago.

This center shades off into a secondary business area which merges almost imperceptibly with a large area of mixed land uses and rundown buildings. This is the slum area where living conditions are poor.

Around the slums is an even larger area of residential property in various stages of depreciation. This is the widely discussed blighted area. Without the application of effective remedial measures, it, too, may become part of the city's slums.

Beyond these blighted areas are the newer residential areas. They extend far out beyond the city limits, in the form of widely scattered subdivisions merging almost imperceptibly into the farm lands.

Interlacing through all of these sections are main highways and streets, and railroads extending into the heart of the city. Along the railroads the city's industrial plants are located. The newer ones, such as the large war industries, are often found far out in the environs.

While every city contains some admirable features and thoroughly satisfactory parts, rapid expansion and virtual transformation in recent years have produced an unbalanced condition fraught with great economic difficulties. Few cities have managed to grapple successfully with the situation. In nearly all cities great efforts are being made today to restrain excessive decentralization, and to rehabilitate slum and blighted areas.

The plight of the cities is due to the most rapid urbanization ever known, without sufficient plan or control. The result is square mile after square mile of developed city that is functionally and structurally obsolete both as to buildings and neighborhood arrangements.

The automobile has made partial escape from this undesirable state of affairs easy and pleasant for at least some of the population, and suburban home developments have been made attractive largely by

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the possibilities of quick and individual daily transportation thus afforded.

Suburban business centers have followed the clustering of suburban homes. The more recent growth of the parking problem with its attendant difficulties of retail trade in the central business section, has to a limited extent induced an outward movement of some large emporiums and a more numerous establishment of branch and chain stores in suburban communities.

Modern industrial processes, requiring more ground space than is available at permissible cost within the city, have been and will continue to be the cause of a preference for outer locations as industrial sites [illegible] are best served by transportation facilities, including highways.

From the standpoint of the city, as a corporation, a serious effect of the outward movement of residence, business, and industry has been the depreciation in value of city-contained land and property available by taxation for the financial support of the city government and the various services it must supply to its residents.

And finally another disadvantage, affecting important city interests has been the increasing tendency toward the diversion of trade from established retail commercial concerns located in the central business district to enterprises newly founded in outer sections, often without the city boundaries.

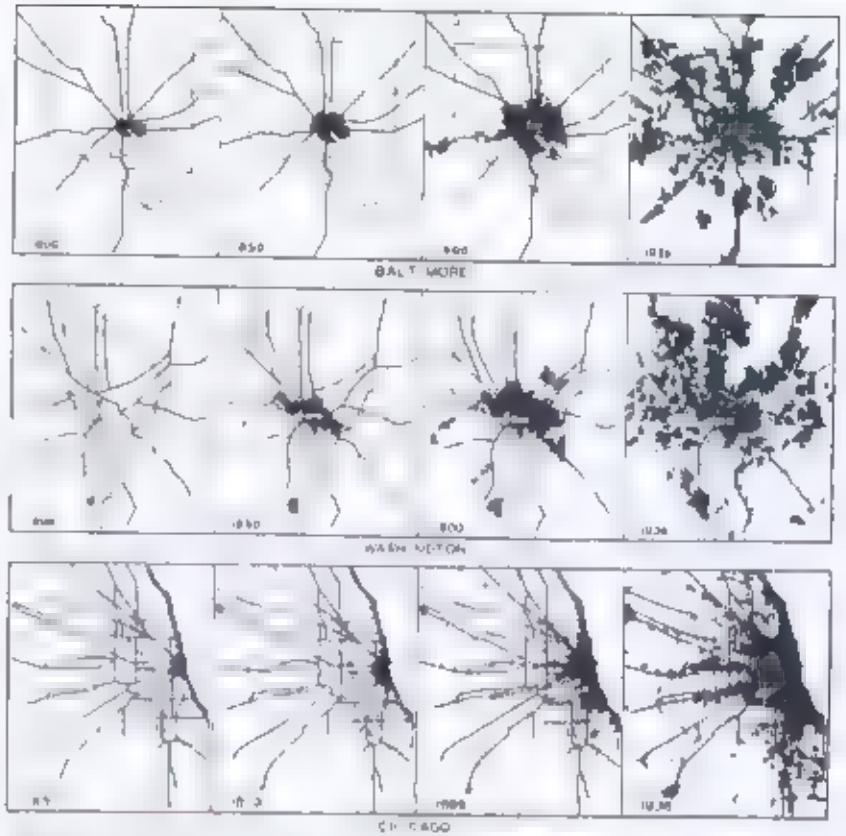
What the city will be like in the future depends on whether its future development [illegible] several new conditions however, will greatly affect city development. One of the most important of these is that future population growth of cities will be [illegible]. To base the planning of highways or anything else on expectations of urban population increases like those of the past, would seem to be unwise.

Twenty-five years ago there was virtually no control of growth and [illegible] city planning. Today many cities have plan commissions and a city plan in some stage of development.

Urban planning is really just now coming to grips with one of the basic urban problems—decentralization or dissipation of the urban area to an extent not economically justified. This is a most difficult problem to solve. So long, however, as the central areas of the cities are poor places in which to live and rear children, people will continue to move to the outskirts. Undoubtedly a factor that has facilitated this movement has been the improvement of highways.

If for any city maps are prepared representing in bold silhouette the areas of the city and its environs occupied by buildings at definite successive periods of its history, it is possible to obtain a clear idea of the manner of the city's growth. The series of such maps for several cities (fig. 26) illustrate typical growth processes common to many cities.

One of the most striking revelations of these maps is the manner in which, in the more recent periods, the growth of the cities has been extended out [illegible] slender fingers along the main highways entering the city. This is undoubtedly due to the improvement of the main highways, which has resulted in a relatively satisfactory connection of bordering areas with the city.



[illegible]

Between the outstretching fingers of development along the main highways, pronounced wedges of relatively undeveloped land appear in the maps for each of the recent periods. Attention will be called to these wedges of undeveloped land again later in this report.

The immediate inference from these maps is that the creation of such ample and efficacious traffic facilities as the improvement of the interregional routes would supply will exert a powerful force tending to shape the future development of the city.

It is highly important that this force be so applied as to promote a desirable urban development. If designed to do this, the new facilities will speed such a development and grow in usefulness with the passage of time. Unwise creation of the interregional routes might not be sufficiently powerful to prevent a logical future city development, but would be powerful enough to retard or unreasonably distort such development. The interregional highways must be designed for long life. An unwise location would diminish their usefulness as time passes.

Principles of Route Selection in Cities

While the selection of routes for inclusion in the interregional system within and in the vicinity of cities is properly a matter for local study and determination, the Committee suggests the following principles as guides for local action

Connection with city approach routes.—Selection of interregional routes within and in the vicinity of a city should be made cooperatively by the State highway department and appropriate local planning and highway authorities and officials.

For the service of interregional traffic and other traffic bound in and out of the city to and from exterior points, the problem is one of convenient collection and delivery. The State highway department should have the primary responsibility of determining the detailed location of routes leading to the city, as it will have the essential knowledge of origins and destinations of the traffic moving on the adjacent rural sections of the routes.

Once the routes enter the environs of the city, however, they become a part of the sum total of urban transportation facilities, and as such must bear a proper relation in location and character to other parts of the street system. In addition to the traffic to and from exterior points, they will carry a heavy flow of intraurban movement of which city authorities will have knowledge or will be best able to measure or predict.

In some urban centers, cooperation between the State highway department and local authorities will be complicated by the fact that the metropolitan area will consist of several cities and perhaps one or more county jurisdictions and that decisions will need to be reached on a metropolitan rather than a city-by-city basis. Recognizing the difficulty of unifying a multiplicity of local agencies, the Committee believes that the creation of an over-all authority would be highly beneficial and desirable in complex urban areas. A metropolitan authority would avoid obvious mistakes in the location of the interregional routes and thus prevent distortions in the development of the area. Only through some over-all agency such as a metropolitan authority can there be developed an adequate thoroughfare plan to provide for all traffic needs. The interregional routes should be coordinated with the metropolitan street and highway plan. Such a metropolitan authority could anticipate and avoid obvious mistakes in the location of the interregional routes, prevent distortions based on short-sighted compromises, and in the long run lead to the best solution for all concerned.

Penetration of city. Because of the traffic congestion encountered in passing through cities, it is the usual conclusion of those who make long automobile trips that they could save much time and avoid annoyance if so-called bypass routes were available to carry them around all cities. Comparative travel-time studies usually confirm this impression.

Such a study at Lafayette, Ind., for example, showed that the average time required to travel 6 miles through the city between two points on U S 52 was 14 minutes. To travel between the same two points over 6¾ miles of existing roads around the city required an average of 9 minutes.

Another example is afforded by a recently constructed 9.5-mile route around Newport News, Va., from the James River Bridge to

Fort Monroe. At 35 miles per hour this bypass can easily be traveled in 16 minutes. The old route through the city was 11.2 miles long and required a minimum of eight stops. Travel time at off-peak hours averaged 29 minutes and during rush hours was considerably longer. The new route, therefore, saves at least 13 minutes and avoids the necessity of frequent stops and starts.

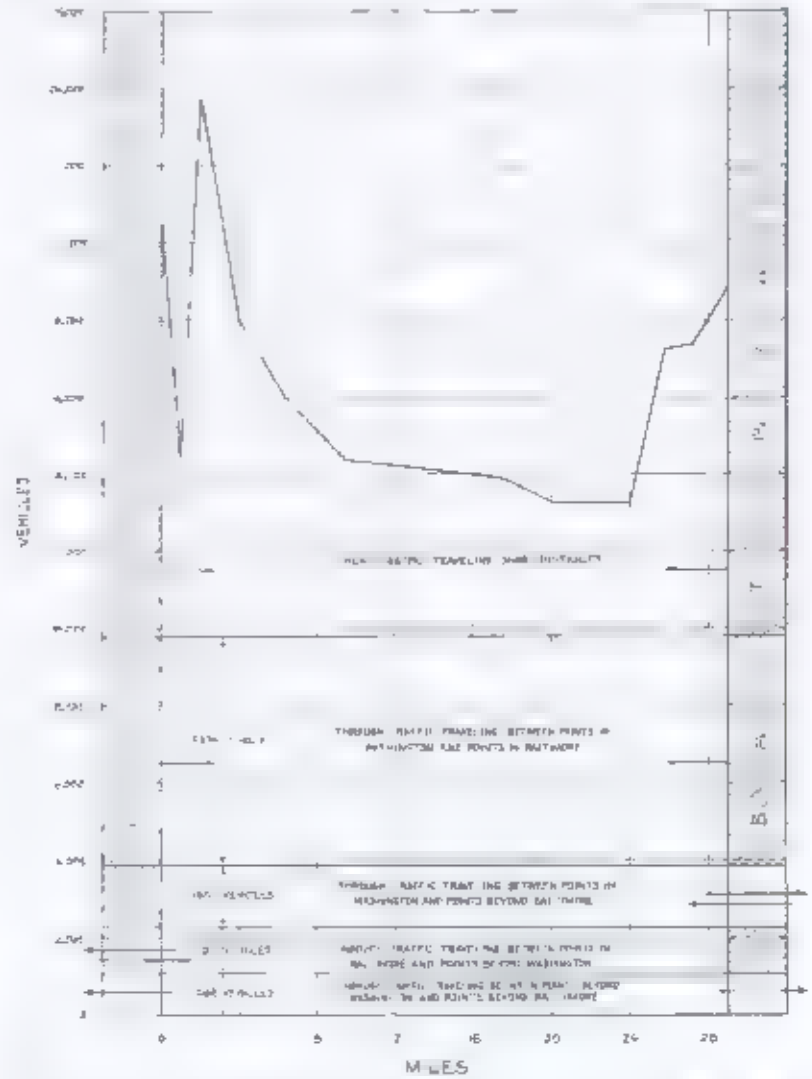


Figure 2.—Origin and destination of vehicles traveling on U S 1 between Washington and Baltimore.

By such actual time studies it is demonstrated that through travelers would be saved time and annoyance and much of the cost of stopping and starting at numerous street intersections if convenient routes were provided around all cities. Such routes undoubtedly have a proper place in a well-designed system of traffic arteries for any city

But the common impression that provision of such routes would constitute invariably a complete, or even a substantially adequate, solution of the highway problem at cities is not well-founded. It is a fallacious conception of the need for adequate accommodation of the traffic moving over the rural highways. From the standpoint of the cities it fails as a solution of the most serious aspects of the problem.

The root of the fallacy, so far as the rural highways are concerned, lies in the fact that even main highways at the approaches to any city, especially the larger ones, a very large part of the traffic originates in or is destined to the city itself. It cannot be bypassed.

This fact was demonstrated by the Public Roads Administration in its report entitled "Toll Roads and Free Roads," published in 1939,[8] by reference to studies of the origin and destination of traffic observed on U S 1 between Washington and Baltimore. A diagram presented in that report is here reproduced as figure 27. The text that accompanied it is as follows:

> As shown by the topmost line in this graph, the total traffic on the route rises to a peak at each city line and drops to a trough between the two cities. Of the total traffic, that part above the highest of the horizontal lines represents movements of less length than the distance between the cities. At each city line this part consists of movements into and out of the city all of which are of shorter range than the distance to the neighboring city. The uniform vertical distance between [illegible] represents the amount of traffic on the road moving between points in each city. The height of the next lower horizontal band represents the traffic moving between Washington and points beyond Baltimore, that of the next, the traffic moving between Baltimore and points [illegible] the height of the lowest band represents the volume of the traffic moving between points that lie beyond both Baltimore and Washington. Of all the traffic shown as entering the two cities, only this last part [illegible] be counted as potentially bypassable around the two cities. At Washington this bypassable maximum is 2,269 of a total of 20,500 entering vehicles; at Baltimore [illegible] the remainder of the entering traffic [illegible] a large part would penetrate to the very heart of the city, because that is where most of it is destined, and conversely it is at or through the same center that one must look for the source of most of the city-originated emerging traffic.

An origin-destination study of the traffic on this same highway was made at an earlier date by Coverdale & Colpitts[9] at a point near Baltimore. It serves further to illustrate the manner in which the traffic approaching a large city by a typical main highway is distributed to the center and various quarters of the city and, via various other main routes, to points beyond the city.

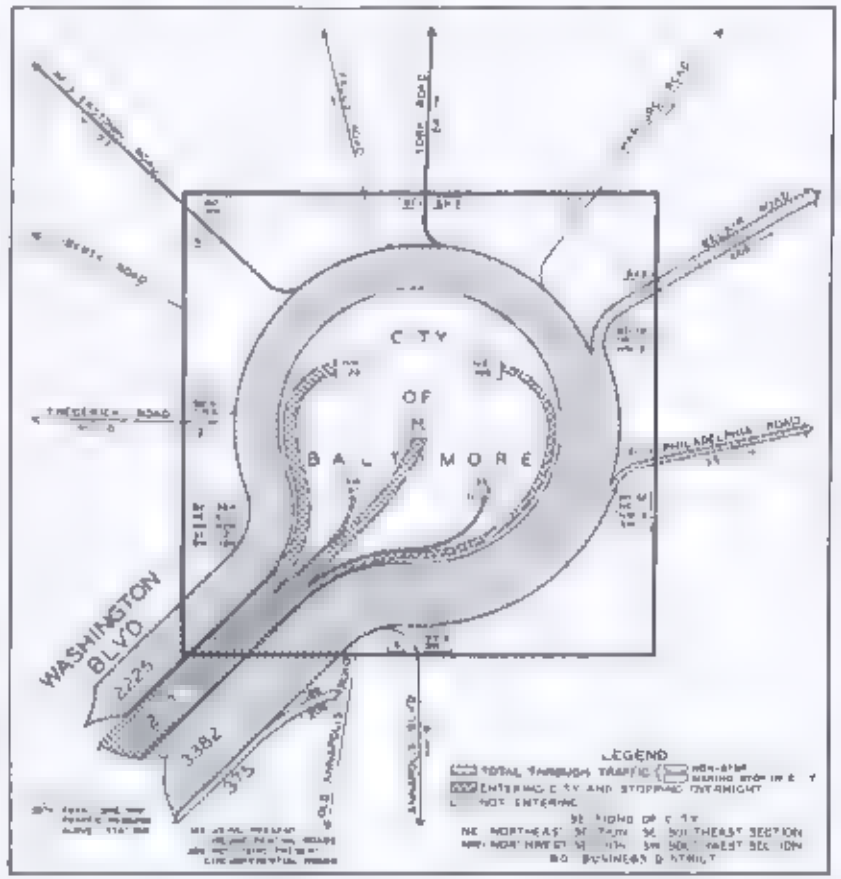
Figure 28 is adapted from the report of this study. It shows that of a total of 5,874 vehicles approaching the city, 717 moved to the center of the city as their ultimate destination. Others, numbering 728, 398, 113, and 163, respectively, proceeded to ultimate destinations in the northwest, northeast, southeast, and southwest quarters of the city. A large number, 2,225 vehicles, went to points within the city (largely in the central portion) and returned the same day by the way they had come. Seventy-one vehicles, bound to points beyond Baltimore, made stops in the city before proceeding to their ultimate destinations, and the remainder, totaling 1,157, or 21 percent of the city-entering traffic passed through the city and emerged by several other main highways en route to destinations beyond the city.

[8] See footnote 6.

[9] Report by Coverdale & Colpitts, consulting engineers, New York, N. Y., to the State Roads Commission of Maryland, 1932.

Like studies by Coverdale & Colpitts, made at the same time on the other main routes approaching Baltimore, showed a similar distribution of the entering traffic.

The conditions which these examples describe are not peculiar to Baltimore and Washington. They are typical of the conditions that exist at all large cities. On all main highways approaching such cities a very large proportion of the traffic will be found upon investigation



[illegible] Diagram of the volume and destination of traffic approaching Baltimore on the Washington [illegible] and [illegible] as observed by Coverdale & Colpitts in 1932. Adapted from a report to the State Roads Commission of Maryland, 1932.

to have originated in or to be bound to the city as its ultimate or intermediate objective.

In general, the larger the city the larger is the proportion of the traffic on the main approach highways that is thus essentially concerned with the city.

As evidence supporting this generalization, reference is made to table 14 and figure 29 which record the results of origin-destination studies made at 27 cities of various population classes, from 6 of less than 2,500 persons to one of a population between 500,000 and

1,000,000 persons. As will be observed, the studies made at 3 cities of 300,000 or more population show that upward of 90 percent of the traffic moving toward those cities on main approach highways consisted of vehicles bound to ultimate or intermediate destinations within the cities themselves. For the 4 cities of 50,000 to 300,000 population the [illegible] proportion of city-bound traffic was found to be above 80 percent. For the smaller cities, the corresponding proportion tends to decline, reaching 50 percent for the cities of less than 2,500 population that were studied.

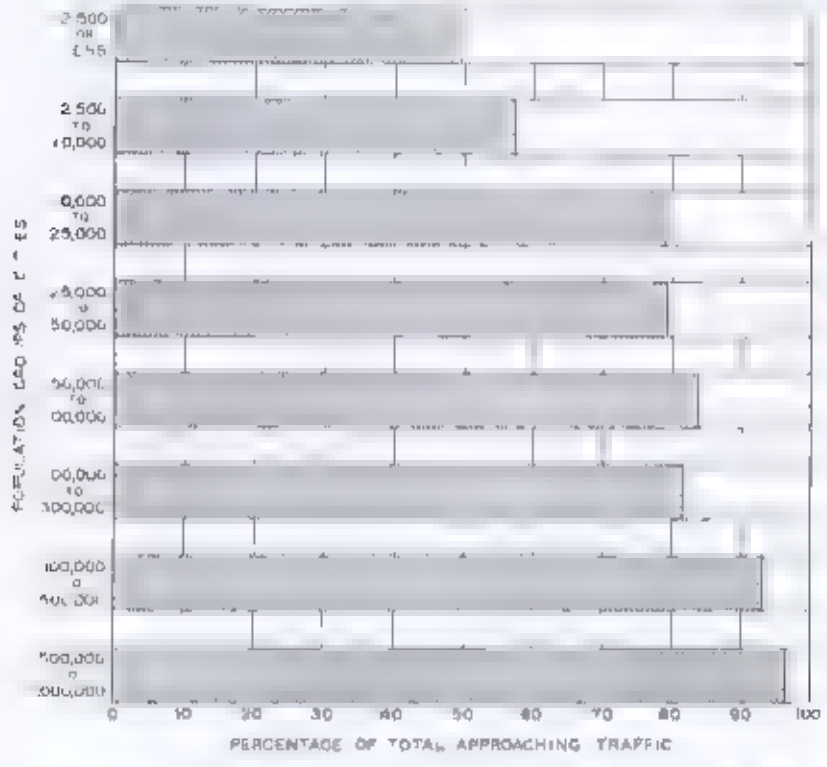


FIGURE 28.—Graphs showing the distribution of traffic approaching cities of various population groups. The average percentage city bound and the average percentage which could have bypassed the cities.

TABLE 14.—*Proportions of traffic bound to and beyond cities of various populations as shown by origin-and-destination surveys on highways approaching 37 cities*

Population group	Number of cities	Traffic bound to or from the city	Traffic that could have bypassed the city
		Percent	Percent
Less than 2,500	6	49.3	50.7
2,500 to 10,000	[illegible]	56.7	43.3
10,000 to 25,000	3	78	21.9
25,000 to 50,000	[illegible]	79.0	21.0
50,000 to 100,000	4	83.8	16.2
100,000 to 300,000	2	81.6	18.4
300,000 to 600,000	[illegible]	92.8	7.2
600,000 to 1,000,000	[illegible]	95.8	4.2

The proportion of adjacent main-highway traffic generated by the smaller cities, either as points of origin or points of destination, depends a great deal upon the location of the city in relation to cities of larger population. A town of 2,800 population, such as Laurel, Md., located on the main highway midway between two such large cities as Baltimore and Washington, which are separated by only 30 miles, will be neither the origin nor the destination of a large part of the heavy traffic counted on the main highway near its boundaries. In contrast, a town of approximately the same size, such as Carson City, Nev., will be found to be the source or destination of a larger part of the lighter traffic on the highway connecting it with its somewhat larger neighbor, Reno.

Similarly, among slightly larger cities, the city of Milford, Conn., a city of more than 11,000 persons, [illegible] as a possible, as origin or destination, for a comparatively small part of the heavy traffic on the great main artery near its city limits. Located midway on U S 1 between the neighboring larger cities of Bridgeport and New Haven, it is directly in the path of the New York-Boston movement.

Annapolis, Md., a city of 13,000 persons is on the other hand, either the origin or destination of a much larger part of the traffic on the spur highway that connects it with Baltimore, 30 miles away.

Among the smaller cities differences of geographic location and interurban relationship may somewhat disturb the rule. It nevertheless [illegible], and among larger cities will be found, that the larger the city the larger will be the share of the traffic on the approach highways that has its origin or destination in the city.

Furthermore, of this city-concerned traffic, the largest single element originates in or is destined to the business center of the city. This is the area in which are located the larger stores and warehouses, both wholesale and retail, the principal banks and other financial institutions, the seat of the city government and the courts, the bigger hotels and theaters, some of the larger apartment houses, and the more influential churches. Usually it includes the principal transportation terminals, some industrial establishments, and occasionally one or [illegible] schools and colleges, [illegible] gallery and music hall and other cultural institutions. Generally it is also the site of the original settlement of the city.

The locations of the principal rail and water terminals have been powerful factors in shaping the business center. Within the foreseeable future, this area is likely to remain the objective and the source of a large part of the daily street and highway traffic. It is reasonable to conclude, therefore, that the interregional routes, carrying a substantial part of this traffic, should penetrate within close proximity to the central business area.

How near they should come to the center of the area, how they should pass it or pass through it, and by what routes they should approach it are matters for particular planning consideration in each city. Since these routes should be designed to serve important arterial flows of intraurban as well as interurban character, their locations from the fringes to the center of the city should be determined in large degree by the location of internal areas in which are generated important volumes of the intraurban movement.

The city streets over which the urban mileage included in the recommended interregional system has been measured, are those now marked as the transcity connections of the existing main rural highways that conform closely to the rural sections of the recommended routes. These streets generally pass through or very close to the existing central business areas of the cities.

The total mileage of these streets in cities of 10,000 or more population has been classified with respect to the use of the land in the areas they traverse. This classification shows that 10.5 percent of the mileage lies within the central business areas of the cities.

In reaching the central sections, these streets pass through several other classes of development, and the percentage of mileage within areas of each class is shown in table 15. As will be seen from this table approximately 7.5 percent of the length of these existing streets in cities of 10,000 or more population is located in areas classified as industrial, 12.2 percent in outlying business areas, 24.3 percent in areas described as mixed business and residential, 23.8 percent in residential areas, 14.7 percent in areas of scattered development, 3.4 percent in park or other municipally owned areas, and 3.6 percent in areas of other description.

As a further indication of the character of these traversed areas, table 15 also shows those wholly or partially devoted to residence classified as high, intermediate, and low class. The greater part of the mileage falls in what are described as areas of intermediate class.

Since it is probable that in any development of the interregional routes, the locations chosen will not follow the streets presently used in many cases, the percentages and detailed data given in table 15 can be considered as only generally indicative of the land uses in the areas that will be traversed, and of the nature of land-acquisition problems involved in the development.

Location internally through wedges of undeveloped land.—As previously pointed out, the improvement of highways at urban centers has tended to cause ribbon-like outward extension of city growth, and has left wedges of relatively undeveloped land between these ribbons of development along the main highways entering the city. To some extent these wedges are the result of a topography less favorable for development or of the reservation of land for various public uses. In most cases they are caused in part by the lack of satisfactory connection with the city, either by roads of direct entrance or by appropriate transverse connection with the main highways.

Whatever their cause, existing wedges of vacant land may offer the best possible locations for city-entering routes of the interregional system. Alinement and right-of-way widths appropriate for the new highways and difficult of acquisition in more developed areas, may be obtainable in these vacant spaces with relative ease and at moderately low cost. So placed, the routes may often be extended far into the city before they encounter the greater difficulties of urban location.

In choosing these locations for the arterial routes, however, it should be recognized that the undeveloped lands which lie so favorably for highway purposes also present opportunities equally favorable for other purposes of city planning. Properly preserved and developed they can become the needed parks and playgrounds for residents of adjacent populated areas. Alternatively, they can be developed as new residential communities in the modern manner, unhampered by

TABLE 15.—*Classification of urban lengths of existing highways conforming to tentatively selected interregional highway routes in all cities having populations exceeding 10,000, by population groups*

MILEAGE CLASSIFICATION

Population group	Central business	Industrial	Outlying business	Mixed business and residential			Residential			Scattered development			Park or other municipal areas	Other	Total
				Class 1	Class 2	Class 3	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3			
1,000,000 or more	18.3	5.7	12.8	6.5	14.8	1.3	5.2	15.	[illegible]	2.0	9.6	7.5	4.8	9	170.9
500,000 to 1,000,000	[illegible]	12.0	[illegible]	[illegible]	[illegible]	4.3	18.9	16.5	3		7.7		0.8	7.6	[illegible]
250,000 to 500,000	[illegible]	4.9	40.8	12.4	34.	11.6	7.6	13.	4	4	4.9	28.4	0.9	9	247.7
100,000 to 250,000	46.7	[illegible]	57.5	3	72.4	9.2	3.5	46.1	9.5	9.5	26	3.5	2.3	23.7	[illegible]
50,000 to 100,000	[illegible]	2.0	44.5	[illegible]	[illegible]	4	[illegible]	[illegible]	4.3	[illegible]	[illegible]	2.4	2	[illegible]	[illegible]
25,000 to 50,000	[illegible]	1.5	2	6	0	1.3	32	60.	8.6	4.3	14.6	2.9	8	[illegible]	[illegible]
10,000 to 25,000		23.7	35.4	25.7	[illegible]	15.5	[illegible]	95	10.5	3.0	5.3	[illegible]	5	9.7	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PERCENTAGE CLASSIFICATION

Population group	Central business	Industrial	Outlying business	Mixed Class 1	Mixed Class 2	Mixed Class 3	Residential Class 1	Residential Class 2	Residential Class 3	Scattered Class 1	Scattered Class 2	Scattered Class 3	Park or other municipal areas	Other	Total
1,000,000 or more	10.9	4	[illegible]	[illegible]	9.4	2.4	3.0	[illegible]	2.4		1	4.3	[illegible]	5	[illegible]
500,000 to 1,000,000	[illegible]	[illegible]	4	6.9	[illegible]	2.9	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0.3	[illegible]	[illegible]
250,000 to 500,000	[illegible]	2	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	[illegible]	1	9	[illegible]	[illegible]	2.4	[illegible]
100,000 to 250,000	[illegible]	[illegible]		[illegible]	[illegible]	6		[illegible]	[illegible]		6	1	[illegible]		[illegible]
50,000 to 100,000	4	1		[illegible]	[illegible]	[illegible]		[illegible]	1.5	[illegible]		[illegible]	9	1	[illegible]
25,000 to 50,000	[illegible]	4.6	[illegible]	3		2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	100.0
10,000 to 25,000	4	[illegible]		5.4	5	5	4	1	[illegible]	[illegible]	[illegible]	[illegible]	2	3.5	100.0
Total	[illegible]	[illegible]	2	[illegible]		4.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.0
		30.2			[illegible]			[illegible]			[illegible]		[illegible]	[illegible]	[illegible]

NOTE.—Class 1, class 2, class 3 are high-class, intermediate-class, and low-class, respectively.

previous commitment to the traditional rectangular street plan. It is highly desirable, therefore, that the location and plan of the new [illegible] with other appropriate uses of the now vacant land. Wherever possible, plans for all uses of the land should be jointly developed and acquisition for all purposes of public use should proceed simultaneously

In any case, if the new city-entering highways are located through [illegible] developed existing suburban areas, which are usually located along the present main highways, in order to serve effectively the arterial needs of these communities. Adequate cross highways at suitable points will provide these connections. And continued around the city from one new arterial and one existing main highway to another, these connectors become the circumferential routes which are discussed later in this section. Some of these circumferentials, especially those forming the outer belt, may appropriately belong in the interregional system, as they would serve both to distribute the city-bound interregional [illegible] another

It will be at once apparent, however, that if the improvement of main highways in the past has resulted in the stringing out of city growth along them, the superior improvement contemplated for the [illegible] as to discourage ribbon development and the unwise subdivision of large tracts of suburban land. Special preventive measures will prove helpful in this connection. One of these measures, applicable at the appropriate stages of city growth, would be to provide additional [illegible], and then, as the interradial spaces widen, to add branches to the radial arteries, thus encouraging uniform development of whole areas rather than ribbon-like settlement along the radials. Another, which involves no principle of route location, is mentioned here only because of its bearing upon city development. It is the control and limitation of access to the arterial routes.

Unlimited access to the existing main highways has undoubtedly encouraged the outward extension of settlement along them. Per contra, the denial of access to the new arterial highways for a substantial outward distance beyond any desired points on these highways would probably discourage the creeping of settlement along [illegible] committee in principle.

Circumferential and distribution routes. Although, as previously indicated a large part of the traffic on interregional routes approaching the larger cities will generally have its origins and destinations in the center of the city, substantial fractions will consist of traffic bound to and from other quarters of the city. Another portion—its volume [illegible] of other [illegible] will consist of traffic [illegible]

To serve this traffic bound to or from points other than the center of the city, there is need of routes which avoid the business center Such routes should generally follow circumferential courses around

the city, passing either through adjacent suburban areas or through the outer and less congested sections of the city proper

Generally, such routes can be so located as to serve both as arteries for the conveyance of through traffic around the city between various approach highways and as distribution routes for the movement of traffic with local origins and destinations to and from the various [illegible] the topography and plan of each particular city. At most relatively [illegible] the road will be for routes entirely [illegible]

In the larger cities more than one circumferential route may be needed. A series of them may be provided to form inner and outer belts, some possibly within the city itself, others without In the largest cities one such route may be required as a distributor of traffic about the business center. Often, it may be possible to serve this function by suitable locations of several of the main penetrating arteries

Not all of these routes may be needed for the service of traffic on the interregional system, however. In some cases the needs of the interregional traffic may be largely met by a route around one side of the city, traversing only a part of the city's circumference.

Relation to traffic-generating foci and terminals.—Railway terminals, [illegible] character, and significant fractions are associated with the essential interchanges between the several modes of transportation Both passengers and freight are transferred between railroads and ships and passengers between railways and air lines. The future development of commercial air cargo and express freight transportation should not be underestimated in considering this shuttle movement between transportation media.

Railway terminals and docks are commonly located at mid and low city points The principal airports probably must remain at or beyond the fringe of the city

The location of the interregional routes at cities—both the city-penetrating main routes and the circumferential or distribution routes—should be so placed as to give convenient express service to these various major traffic-generating foci within and in the environs of the city, and also to the business center of the city, the wholesale produce market, main industrial areas, principal residential sections [illegible] park, and other sports areas.

Location of the routes should be determined in relation to such foci in the positions where they are planned or are likely to be in the future and not where they are at present, if change is reasonably to be expected. Thus the closest possible cooperation is needed between highway, housing, and city planning authorities, railroad, motorbus, [illegible] agencies, groups and interests that may be in a position to exert a [illegible] the city

Moreover the highways themselves should have their own adequate terminal facilities facilities hitherto sadly lacking There are two general classes of highway terminals—those designed for the daily or overnight accommodation of private vehicles (principally passenger

cars with destinations at the center of the city, and those serving the organized transportation business of bus and truck lines.

The former (generally termed parking garages) constitute a more or less separate problem which is more fully discussed later in this report.

The latter are interrelated with the terminals of other transportation media, such as those of rail, water, and air.

Union bus terminals are desirable. They should be located at points convenient for express highways to provide for accurate interchange of passengers with railroads, wharves, and airports, and for quick distribution of passengers from and to the principal city areas where their trip origins and destinations lie.

Truck terminals also should be conveniently accessible by the express highways and these should be located at points appropriately chosen to facilitate the transfer of freight to and from railroad and water transportation especially. Again union terminals are desirable, not only for convenience of transfer to other modes of transportation but also for promotion of the possibilities of return truck loads.

Different classes of freight may require the establishment of more than one such terminal. The terminal for industrial freight, for example, should be located in or convenient to the area of principal industrial concentration. Another terminal may be required in or near the commercial center; and another at a point convenient for the transfer and delivery of agricultural produce. The latter would serve as both a truck and produce market and should be designed accordingly in both location and space accommodation.

By classes the essential service requirements of these highway terminals for passenger and freight will be found within certain more or less prescribed areas, and thus prescription will have an important bearing upon the location of the interregional and other express highway routes.

Relation to other transportation media.—At cities, especially, it is important that the location of interregional routes be so chosen as to effect or encourage a desirable coordination of highway transportation with rail and water, and air transportation. In this regard it may be mentioned that opportunities for joint use of new structures by the interregional routes and mainline railroads should not be neglected wherever they may appear. The feasibility of combination rail-and-highway tunnels to eliminate the costs of snow removal or protection and to reduce grades over some western mountain passes, should be carefully investigated. It will be desirable to study at numerous points the possibilities of providing in a single structure whether bridge or tunnel for the crossing of rivers and other bodies of water by interregional routes and main railway lines.

However, it is at the cities—terminals alike for the interregional routes and all other transportation media—that the closest attention should be paid to the possibilities of common location, and also to such location of the highways as will best and most conveniently serve to promote their use in proper coordination with other transportation means.

There are possibilities of the development of common city approaches of rail and highway, either on parallel surface or depressed locations or with the highway above a railway tunnel. These possibilities should be carefully explored.

In many cities the surface location of railways remains as one of the more acute problems facing the city planner. Instead of attacking this problem piecemeal by elimination of grade crossings one or two at a time, a practice which tends merely to ameliorate a generally unsatisfactory condition, it would be far better if it were dealt with in accordance with a plan for the complete and permanent insulation of the railway. Since the interregional routes and other express highways require, in some degree, a similar insulation, a plan for the common location of the two facilities might offer not only the advantage of a minimum obstruction of cross streets but also a substantial possibility of reducing the total costs of achieving the two purposes, particularly the right-of-way element of such costs. A striking development of this character in the city of New York is illustrated in plate I.

Relation to contemplated developments requiring large tracts of land.—Wherever it is possible to do so, the location of interregional routes in cities should be considered simultaneously with the proposed location of new housing developments, civic centers, parks, grade crossings, and other contemplated major changes in the existing city pattern that call for the acquisition of land in large tracts. This is necessary for the avoidance of conflicts in plans. It is necessary from the standpoint of adequate transport accommodation; and it is highly desirable from the viewpoint of common land acquisition and financing. The location of express routes within or adjacent to such areas may be one of the most fruitful means of avoiding street intersections, which should properly be applied subject to a proper regard for the character, uses, and needs of the several areal developments.

Minimization of street intersections.—In the operation of motor vehicles we are conscious today as never before of the enormous gasoline costs of stopping and starting.

Investigations by the Iowa State College on the wear of tires show, for example, that at the wartime maximum speed of 35 miles an hour, a single stop and start normally wears away about as much rubber as a mile of travel.

Other investigations by the Iowa college have determined that at the same uniform speed, a single stop and start by an average passenger car consumes as much gasoline as 0.15 mile of driving on a straight highway of average gradient.

Under any circumstances stopping-and-starting costs constitute tangible amounts worth saving.

The frequency of street intersections is the cause of excessive stops and starts in cities. Every intersection also introduces substantial elements of delay and congestion.

If the permissible speed of moving traffic is 35 miles per hour, a halt of only half a minute at a traffic light consumes time in which each halted vehicle, but for the stop, would have advanced nearly 4 average city blocks. On a street carrying a daily traffic of 10,000 vehicles, if this traffic were equally distributed throughout the 24-hour day, one such traffic light operated on a half-minute interval would prevent 730 vehicle-miles of movement in a single day.

These calculations ignore the time lost in starting and stopping. If this also were subtracted, the total daily loss of vehicle-mileage might easily be doubled, and 10 lights under these conditions might rob the entire traffic stream of nearly a mile and a half of movement daily.

The Public Roads Administration's studies of the traffic-discharge capacity of highways have reached the conclusion that a one-way, two-lane roadway with no intersections will discharge without unreasonable congestion an hourly traffic of 3,000 vehicles moving at an average speed of 35 miles per hour. With equal congestion but with three traffic lights per mile, each set on a half-minute interval, the

FIGURE 30.—Map showing the location of traffic accidents in the year 1937 in the city of Houston, Tex., taken from the report of the Houston traffic survey conducted under the auspices of the Works Progress Administration (WPA).

hourly discharge is reduced to at best 1,500 vehicles an hour. One or two more traffic lanes would have to be provided to restore the highway to its intersection-free capacity.

Street intersections also involve the hazard of accidents. As illustrated by the typical traffic-accident map reproduced as figure 30 most of the accidents on city streets occur at street intersections. Where traffic volume is great as it is on arterial streets, reduction of the number of intersections can materially reduce the total of accidents.

PLATE I.—A [illegible] express highway [illegible] railroad [illegible] tracks. The upper view shows construction in progress on the highway deck over New York Central railway tracks. [illegible] completed and landscaped Henry Hudson Parkway built over the tracks.

PLATE II.—Curb parking and the street congestion to which it contributes in a small city (upper), and a large city (lower)

Reduction of the number of intersections presents problems in the design of arterial routes and the control of traffic flow more difficult of solution than similar problems encountered on rural highways. For instance, the ideal arterial street would have no intersections yet it is obvious that all cross streets cannot be closed in order to attain this ideal.

One solution is to eliminate intersections by means of grade separations. Grade separations eliminate the hazards, delays, and costs entailed by encounter with cross-traffic streams. They involve expensive construction, however. A judicious choice of location to minimize the number of intersections is one means of avoiding this expense.

Wherever it is possible to do so with satisfactory accommodation of the local arterial traffic arterial routes should enter the city at points from which it is possible to proceed as near as desirable to the city center and thence to connection with the continuing rural routes at the opposite side of the city, by locations parallel to one or the other direction of the normal rectangular street plan. Such locations will usually encounter a minimum number of street intersections in traversing the city and are generally to be preferred for this reason. They are also preferable to diagonal or curving locations because of the greater simplicity of the intersections.

Locations adjacent to the usually winding or curving bank of a river or the curved or diagonal line of a railroad should be considered as exceptions to the rule stated above. Such locations usually offer the advantage of protected or infrequent access from one side, and this may offset the disadvantage of greater length within the city and consequent number of streets passed on the other side.

Location in proximity to a railroad is generally considered somewhat objectionable. It need not be, however, if by electrification, the use of Diesel power, appropriate screening and landscaping, or other means, smoke, noise, and unsightliness are abated.

The valley of a small stream penetrating a city may offer excellent opportunity for the location of an intersection-free artery. In many cases such small valleys exist in a wholly undeveloped state. In others they are the locations of a very low order of development—neighborhoods of cheap, run-down houses and shacks, abject poverty, squalor, and filth. Where these conditions exist, steep declines into the valley have generally made the site unfavorable for the development of high-class improvements.

Nor is it entirely accidental that these small stream valleys often lead in directions favorable for arterial routes penetrating from the outskirts of the city to points near its heart. In many cases the original settlement of the city grew up about the junction of these small streams with a larger stream, and the place of the original settlement is the center of the present city.

Often a small valley of this kind interrupts completely or more or less effectively many of the transverse streets. Intercourse within the city has already adjusted itself to crossing at relatively few principal points where bridges have been provided. Under these conditions the valley may provide the most fortunate of opportunities for the location of city-entering arterial routes. Its conversion to

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that use may yield the benefits not only of quick and free traffic flow but also of eradication of a long standing eyesore and blight upon the city's attractiveness and health. Even at the expense of some indirection in the location of the route, it may be greatly advantageous to convert undeveloped areas to such use.

Other locations favorable for the reduction or simplification of intersections on the arterial routes may be found within or along the boundaries of parks and other large tracts of city or institutional property that interrupt the regular rectangular street plan. An examination of the city for opportunities of this sort may be rewarded by the discovery that it is possible to project reasonably direct routes from one such area to another with substantial advantage in the reduction of intersection problems.

After an interregional route has been carefully located so as to minimize the number of cross routes, a considerable number will still exist. The grade of all that cannot be avoided should then be separated.

And finally, all sections of the interregional system in cities—those serving as circumferential distributors as well as the city penetrating routes—should be considered as arterial highways of limited access. The principle of limited access is outlined in a later section of this report.

Relation to urban planning. It should be borne in mind that the interregional routes from the standpoint of the city will prove to be only a partial facility for movement of the city's traffic. That part, whether great or small, should be determined in location and designed in character to be a consistent and useful part of the entire urban transportation plan. As previously suggested, the entire plan should be conceived in relation to a desirable pattern of future city development.

The present flow of traffic within the city is affected by the existing pattern of land use, the existing location of railroad and other transportation terminals, the existing concentrations of business, industrial, and cultural establishments, and the existing location of residential areas of various classes. It is probable that many of these existing land uses will be materially changed within the life period of any substantial new traffic facilities now provided. Such material changes must be expected even if there is no planned direction of the course they should take, and the location and character of the new routes provided should anticipate them as fully as possible.

By careful and complete functional studies of the city organism, it may be possible to devise a rational plan of future land use that will assign more or less specific areas to each of the principal classes of use—residential, cultural, business, industrial, etc. Having planned such rational distributions of land use, it may be possible to obtain the public consent necessary to the establishment of legal controls, land authorities, and other devices and machinery that will assure an actual development over a period of years in conformity with the plan. In such case, the planning of city streets, the interregional routes and other express ways, and all other urban facilities would take the forms and locations necessary to serve the intended land uses, and these facilities would be provided in essential time relationship to the development of the entire plan, and in a manner to bring about its undistorted realization.

The interregional routes, however they are located, will tend to be a powerful influence in shaping the city. For this reason they should be located so as to promote a desirable development or at least to support a natural development rather than to retard or to distort the evolution of the city. In favorable locations, the new routes, which as a matter of course should be designed for long life, will become more and more useful as time passes; improperly located, they will become more and more of an encumbrance to the city's functions and an all too durable reminder of planning that was bad.

It is very important, therefore, that the interregional routes within cities and their immediate environs shall be made part of the planned development of other city streets and the private or planned development of the cities themselves. It is well to remember in this connection that observations of the existing traffic flow may not be an infallible guide to the best locations.

In many cities there are city planning commissions that have already given thought to desirable changes in the present city structure. Some of these boards have reached quite definite decisions regarding many of the elements that will affect the location of interregional highways in and near the city. Usually the decisions of the planning commission have grown out of studies of the city as it is and as the commission desires it to be. And these studies will usually afford the principal data and bases for agreement upon the general locations of the interregional routes.

It is especially desirable that the agreement have the full concurrence of housing and airport authorities and other public agencies that may be concerned with the acquisition of large tracts of land in and near the city. This is desirable in order that the routes may be properly located for adequate service of the developments planned, and that the lands needed for the highways and the new industries and developments they are designed to serve may be cautiously agreed upon and simultaneously and cooperatively acquired.

Illustrations of Principles of Route Selection

To illustrate many of the principles of route selection in cities, as well as the range of conditions that may be encountered at cities of various sizes, figure 31 gives schematic lay-outs of several possible conditions of main penetrating and circumferential or distributor routes.

At the small city. The simplest case is that of the small city, illustrated by diagram A. In this case the interregional highway passes on a direct course wholly without the city. The former main highway, which now serves as a city service road, diverges from the interregional route at some distance on opposite sides of the city. This provides a connector between the interregional and the older main highway that passes through the small city. The service road may or may not be considered as part of the interregional system, depending upon the size of the city, its distance from the interregional route, and the relative volume of the traffic the service road and the other main highway contribute to the interregional system. In this case, however, no circumferential or distributing routes are needed.

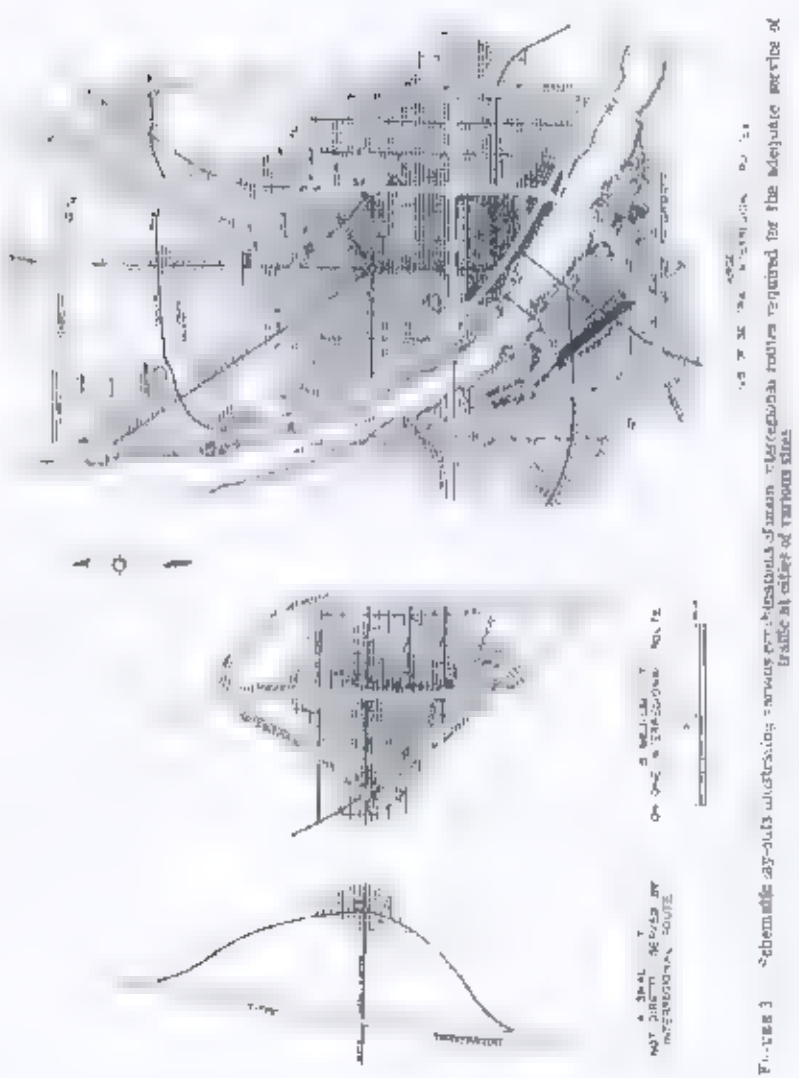


FIGURE 3.—Schematic lay-outs illustrating various principal types of main interregional route required for the adequate service of traffic at cities of various sizes

In the city of medium size.—Diagram B illustrates the case of a city of medium size. In this case a single route of the interregional system approaches the city from the north and south and necessarily passes through the city closely adjacent to the business section to pick up and deliver the substantial volume of traffic there originated or destined.

For the accommodation of the considerable volume of through traffic on the interregional route, a circumferential route, considered as part of the interregional system, diverges to the right at a convenient point south of the city and passes along the eastern boundary to rejoin the main route at a point north of the city. The distance around the city by this route is little if any longer than the distance through the city by the main route. The circumferential route serves also to pick up and deliver traffic at several accesses provided in the city's eastern quarters.

Another main highway, not included in the interregional system, intersects the interregional route at the center of the city. For transfer of through traffic between this route and the interregional route, a circumferential route is provided around the west side of the city, but because of its relatively unimportant service of interregional traffic, this route is not considered as part of the interregional system.

In the large city.—Diagram C illustrates the complex pattern of main and circumferential interregional routes and other local highways that may be required for the adequate service of both interregional and local traffic at a large city. In this case three interregional routes intersect at the city and all must pass within convenient reach of the large central business section.

One follows along the bank of the river as it approaches the city and continues in this location through the city.

Another approaches from the northeast and enters the city through a wedge of undeveloped land which passes [illegible] along the border of a new housing development, skirts the eastern fringe of the business section, crosses the river and [illegible] its southwesterly course as it emerges from the city.

The third crosses the city from east to west, skirting the northern edge of the business section.

In addition, several other principal highways center in the city.

In this case, the three interregional routes combine to perform the function of traffic distribution around the business section.

At convenient points to the north, east, south, and west of the city, interregional circumferential routes intersect the main penetrating routes and serve to transfer through traffic from one to another, and to distribute the interregional traffic to the several quarters of the city. The locations of these routes are such that in no case is the distance around the city materially different from the through distance.

To the north of the city there is considerable scattered suburban development, and the northern leg of the interregional circumferential route crosses east and west above all this development.

An additional east-west distributor closer to the city is located as an inner circumferential route approximately along the northern city limits. It connects with the eastern interregional circumferential and with the riverside interregional route. Since it performs mainly a local distributing service it is not considered as part of the interregional system.

Within the area circumscribed by the interregional circumferential routes, access is provided to the main interregional routes and the circumferential routes at several suburban communities and at certain streets which extend uninterruptedly across the city, and which for that reason are well adapted as internal collectors and distributors of traffic.

The diagrams of figure 31 represent purely imaginary cases. An effort has been made, however, to include in them some of the situations that may be commonly encountered. Study of these diagrams will suggest most of the essential locational relations of the main interregional routes and circumferential and distributing routes, and the difference between circumferential routes that should properly be considered as parts of the interregional system and those that may not be so considered because of their primarily local function.

MID-CITY TERMINALS OF EXPRESS HIGHWAYS

Curb parking of vehicles is generally recognized as a principal cause of the congestion of downtown city streets. The congestion reaches a maximum during the morning and evening hours when the daily flow and ebb of workers' cars are at their height. And the movement of arriving and departing vehicles is impeded by vehicles taking or leaving curb-side parking positions. Typical conditions are illustrated in plate II.

In most cities efforts have been made to ameliorate the greatest congestion by prohibiting rush-hour and all-day curb parking on the downtown streets, or by metering curb parking at rates considered reasonable for short periods but discouragingly high for all day.

Private initiative has contributed a further measure of relief by the provision of off-street parking places. In their simplest and earliest forms these took the form of lots, usually created by razing obsolete and run-down buildings. Located by the chance availability of such property, these lots have not always been suitably placed to meet the parking need.

They are also prepared usually at the least possible cost. Their accommodations for entrance, exit, and sorting are commonly inadequate, and so they often gain an evil reputation for fender smashing and other car damage.

Often unsightly in the extreme and irresponsible in ownership, the manifold defects of many of these places make it impossible to consider them as more than temporary expedients useful until a better and more seemly solution of the parking problem can be provided. Plate III gives views typical of the worst and the best of such parking lots.

More recently a substantial development of off-street parking facilities of a higher type has occurred. In a few instances these have been provided by the municipality. An outstanding example is the underground facility created by the city of San Francisco beneath Union Square Park opposite the St. Francis Hotel. (See plate IV.)

A greater number of the better facilities have been provided by private initiative. In their simplest form they are little more than multilevel parking lots created by the erection of a structure of two or more floors connected by ramps and wholly without walls. One of these is illustrated in the upper view of plate V.

In their most elaborate form they consist of multistoried garage buildings equipped with elevators or ramps, and manned by a staff of attendants to receive and deliver the cars of patrons at entrance and exit points, and to place and remove them from the parking stalls provided on the several floors. A building of this type is shown in the lower view of plate V.

Between these extremes of the better types of privately provided facilities are others which possess merits warranting the belief that they suggest the prototype of the final best solution of the parking problem. As shown in plate VI these in their present stage of development differ from the simplest form illustrated in one of the views of

plate V only by the addition of a grilled wall, and in some instances by the development of the ground-floor frontage for store space to increase revenue.

Functionally appropriate and capable of pleasing architectural treatment, the openwork walls of the parking stories eliminate the necessity of mechanical ventilation, which is essential in underground and closed-building facilities. Thus these self-ventilating facilities reduce the costs of vehicle accommodation.

A further development, the addition of upper stories for certain office and loft uses, might produce additional revenue which would permit the reduction of parking charges to a practicable and generally attractive minimum.

Reduction of the prevailing rates of structures of this type is necessary before they can offer facilities and offer the prospect of a solution to the general parking problem. While they are now usually operated at reasonable profit, this is possible only at parking rates which exclude all but a small percentage of the vehicle owners who must in the future be induced or required to use off-street accommodations.

In a studied development and location of facilities of the type last described, the Committee sees what it regards as the most promising prospect of comparatively satisfactory solution of the parking problem. A number of these parking garages, for instance, each within two or three blocks' walking distance of the destinations of their patrons, are to be preferred to a few larger facilities more distant from the travel objectives of those who must somehow and somewhere be accommodated.

In this connection, the provision of express highways which will concentrate the approach of a large volume of traffic to the business center at a few points, somewhat complicates the problem of distributing the traffic to its eventual convenient places of off-street parking.

Any attempt to discharge the free-flowing express traffic at one point into the surface streets of the downtown section, through such streets to find their way to dispersed parking places, is likely to create an extent confusion and delay that will cause at the end of the express route a loss of much of the time saved by the free movement en route. Such an attempt, moreover, may cause a degree of congestion in the surface streets near the express highway terminus greater than that resulting from the present distributed approach of vehicles.

Termination of the express highway in an open square or plaza, a solution that has been suggested, is certain to encounter troublesome difficulties in channeling traffic through or around the plaza to and from the several connecting streets, and may still throw congesting volumes of traffic upon these streets at the approach to the plaza.

A wholly satisfactory termination of express highways in large cities will probably not be found short of the provision of a limited-access distribution route located circumferentially about the central business section. With traffic interchange facilities at selected streets on the fringe of the business section, such a route will so distribute the discharge and collection of express highway traffic as to (1) minimize the effects of entrance and exit delay upon the flow

PLATE III Parking lots—good and very bad

PLATE V. The Union Square garage of pre-1989 San Francisco. The Saint Francis Hotel is reported to be the world's largest hotel to provide valet parking.

PLATE VI — Examples of open-wall parking garages with grilled walls and [illegible] re frontage (upper) and with upper stories devoted to office loft or other uses (lower) In this case the upper stories are occupied by bowling alleys. Such structures are suggested as the possible prototypes of a most desirable solution of the park[illegible]

of traffic on the express route, (2) avoid excessive discharge or collection volume in any central city street, and (3) extend the advantage of free flow as close as possible to the central points of ultimate origin and destination of the traffic

At traffic interchanges on the circumferential distributor route and at junctions of this route with each entering express road, are points favorable for the location of parking garages. Vehicles that can be conveniently parked at these locations will be kept completely out of the central street system, and the burden upon these streets accordingly reduced. For that part of the traffic that cannot be conveniently terminated at these points, other off-street parking facilities at well-chosen central points will be required, with movement to and from such points by way of the ordinary streets.

LIMITING ACCESS TO THE INTERREGIONAL ROUTES

The character of the interregional routes as main collectors of through traffic justifies the granting of preferential right-of-way to traffic moving on them over all crossing and entering traffic everywhere, throughout the system. A proper facilitation of the express traffic with due regard for safety and economy requires, moreover, a reduction of the number of access and crossing points to a practicable minimum. This is the opinion of the Committee, makes it essential to as promptly as possible, to provide for the legal designation of all routes of the recommended system, in both their urban and rural sections, as limited-access highways. This designation will empower administrative authorities, wherever and whenever necessary for the convenience of express traffic and the promotion of safety, to deny access to the interregional highways from abutting lands or control or limit such access as may be found desirable, and similarly to deny or limit access, as desirable, from other public roads.

Principles of Location and Design for Limitation of Access

The proposal to confer this essential power does not suggest that it be inflexibly or arbitrarily used. To deny access to the routes from all abutting properties will not be necessary invariably. On the more lightly traveled rural sections in sparsely settled areas, it may be reasonable to permit access from substantially all properties. But in any case the place and manner of access should be so defined and controlled as to preserve the character of the express route and, as completely as practicable, to prevent the occurrence of collisions.

In many cases it will be found that unimportant rural cross roads can be closed and their slight traffic directed to other points of crossing. And where, in rural areas, the traffic on the interregional highway is light or only moderately heavy, it may not be necessary, immediately at least, to go to the length of grade separation at all retained intersections. But wherever a grade crossing is permitted on the interregional highway, the design of the intersection and its signing should enable and require operators of crossing vehicles to make a positive determination of the safety of crossing and should reveal to operators of vehicles on the main highway the presence of vehicles about to cross or enter. All traffic should be required to halt before crossing the main highway at grade, but in most cases will the simple posting of stop signs on crossing or entering roads be sufficient. The design of the intersection should additionally provide all physical safeguards, such as definite traffic channels and refuge islands, decelerating and accelerating space, etc., as may be necessary to afford a maximum of safety for both of the intersecting traffic streams and a maximum of facility for the traffic on the interregional highway. A suggestion of what this may mean at a crossing on a section of the system carrying moderately heavy traffic is shown in plate VII.

Where traffic on the rural routes is heavy and, in the environs of cities, where it is desirable to discourage undue extension of road-bordering city growth, prohibition of access to the highway from abutting land, controlled access at specified points and the closure or grade separation of all intersecting highways are essential.

If no prior right of access has existed, as will be the case where rural and suburban sections of the interregional routes are developed on new locations, it may not be considered essential to provide a local service road to abutting lands as an auxiliary of the interregional route. It will probably be necessary in such circumstances, however, to compensate the abutting owners for the denial of their right of access to the new facility.

Where a section of the interregional system is developed on the location of an existing highway to which all abutting properties have previously had unlimited access, it may be necessary to provide properties denied access to the through highway with other means of ingress and egress. This may be accomplished by the construction of roads connecting the affected properties with other existing roads, with improvement of such roads if necessary. In other cases, especially in suburban areas, it may be necessary to provide at each side of the through highway, parallel local service roads connected with the main artery at selected access points. The service roads may provide for one- or two-direction travel, depending upon the amount of traffic to be served and the distance between points of access to the through highway.

It is in cities and their urban fringes, however, that the problems of provision for express traffic and denial of access are most difficult, complex and expensive of solution. As one of the interregional routes approaches a city, denial of access to it may be desirable for some distance outward from the point of first considerable roadside development in order to discourage the further excessive extension of settlement outward. Inward from the point described at which the first of urban accesses should be provided, other access points should be chosen at not too frequent intervals, but so located as to serve with reasonable convenience the express highway needs of the more populous suburban foci.

Proceeding into the city proper, it is desirable that access to the highway be provided only at selected cross streets. As previously indicated, these should preferably be streets that cross the city or extend at least to the next adjacent express highways without interruption, in order that they may serve as clear and direct connections with the express route for as large a territory as practicable.

The usefulness of the express route for intraurban traffic is greatest for traffic between the outer residence areas and the city center. For this reason access points should be provided at shorter intervals near the city limits than near the center. Proceeding toward the center a point is reached at a substantial distance from the route terminus (say not less than a half mile nor more than a mile) between which and the terminus there will be no occasion for further access. Within this distance traffic to the city center can be accommodated more conveniently on the ordinary streets than on the express highway.

At least at the access streets, safe provision for intersecting traffic should be afforded. In the opinion of the Committee, this will invariably require the separation of intersecting grades. As necessary,

other selected streets may be carried over or under the express highway, without access to it. All other streets should be terminated at the parallel local service ways which, in cities, will always be required.

Various means of reducing the number of interrupted streets and grade separations (by suitable location of the express routes) have been discussed in a previous section of this report.

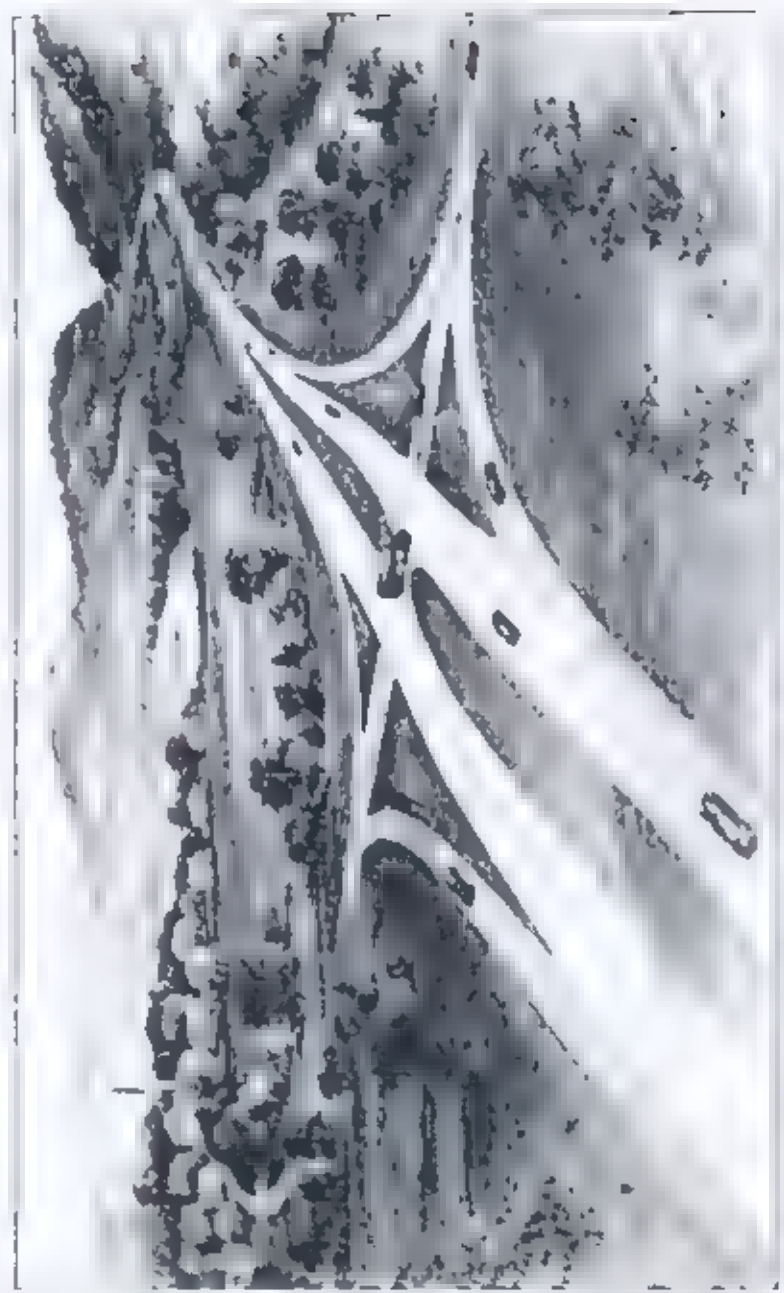
To avoid undue obstruction of the cross movement of pedestrians, foot bridges should be constructed to span the express ways at frequent intervals.

Generally in the largest cities, and under some circumstances in smaller cities, a satisfactory meeting of the conditions imposed, especially near the city center, may require the raising or lowering of [illegible] joining ground level, in order to carry it over or under frequent cross streets or over some and under others. Where the general topography of the city in such sections approaches a level or uniformly sloping plane, continuous elevation or depression of the express route is the indicated solution. Where the topography is rolling the most feasible [illegible] passing over some cross streets and under others.

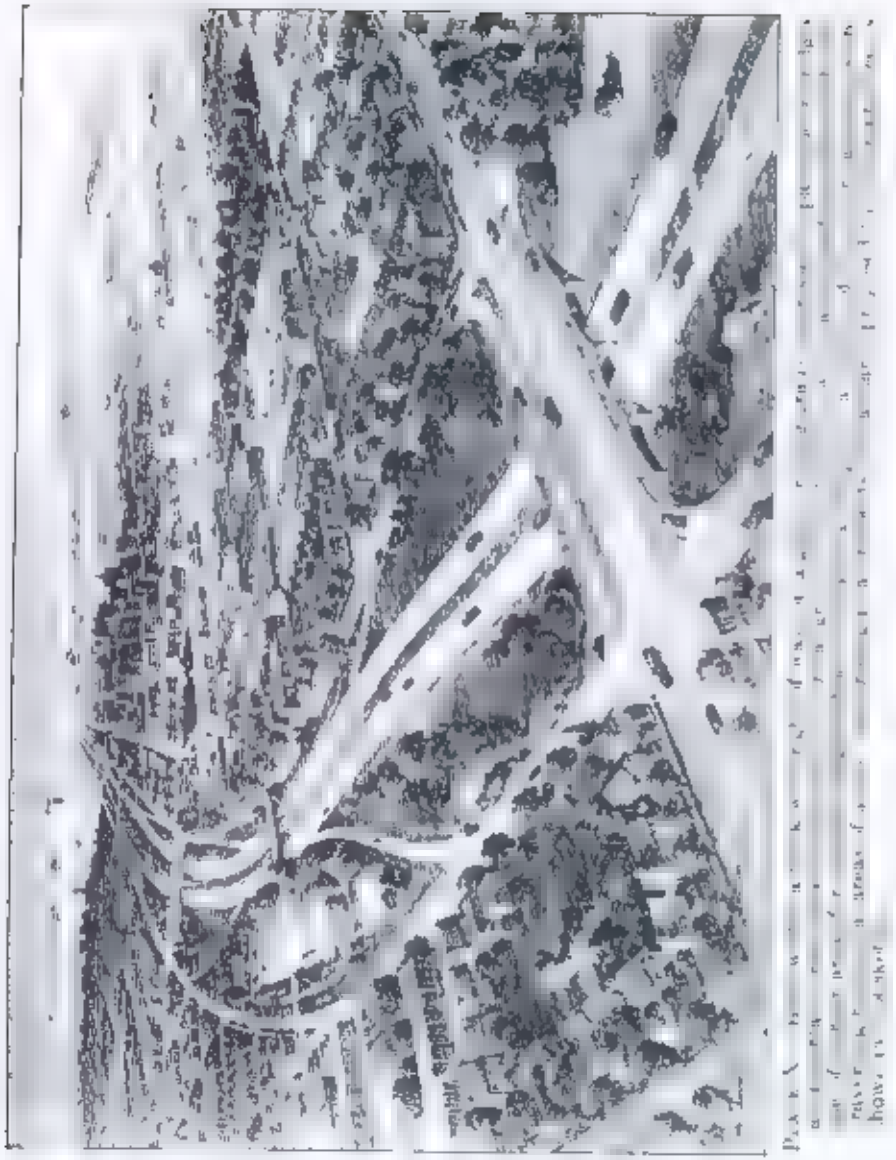
[illegible] generally afforded by existing surface streets will usually result in unsatisfactory design of the express route and impairment of the utility of the surface street for local service. Generally, it will also cause serious damage to abutting property. To avoid these undesirable consequences it will usually be necessary to acquire a right-of-way wider than can be found within the limits of an existing street. This may be done by taking the added width at one side of a street; or a more feasible location, avoiding the taking of property frontage may be found at the rear of properties fronting on adjacent streets. By location of the latter type, damage to adjoining property may, under some conditions, be lessened. In general, the Committee considers elevation of the express routes a solution acceptable only in a commercial or business environment, as shown in plate VIII. It shares what it believes to be a widely held opinion opposing the cutting of such facilities through residential areas.

Depression of the express route will usually require extensive reconstruction of underground facilities, such as water mains, sewers, and electric conduits, and at low elevations drainage may be difficult and expensive. It will rarely be possible to achieve full depression within the width of an existing street. Additional right-of-way acquisition will nearly always be involved. The razing of numerous existing buildings will usually be necessary also, but this under many circumstances, particularly in blighted areas, may be regarded as an end desirable in itself.

Such are the principal difficulties of depressed construction. Where they can be overcome, the resulting development may be considered [illegible] improvement of the urban environment than any other solution of the express-highway problem. Wholly satisfactory design will usually require condemnation of a block-wide strip of property through the [illegible] as local service ways.



[illegible] grade crossing on a four [illegible] ed in conformity with the standards proposed. Note [illegible] deming [illegible] ip on approach to the intersection, tapered acceleration and deceleration space and [illegible] ng areas adjacent to th [illegible] strip. In the distance [illegible] different [illegible] eas where th alignment [illegible] ep



A less satisfactory solution, as shown by the examples in plate IX, can be achieved by taking the tier of properties on one side of an existing street, retaining that street as one of the essential local service ways and constructing another at the opposite side of the depressed route. This will usually result in a somewhat cramped development and will expose to the express route the rear of properties at one side.

It will generally be preferable, however, to the third alternative, which is to take properties on both sides of an existing street. The latter would prevent salvage of the existing street and require the construction of two new service ways, to both of which the rear of abutting properties will be exposed.

In the outer and residential sections of large cities and in small cities generally, neither the elevation nor the continuous depression of express routes is recommended. In such sections a more appropriate design, developed on a block-wide right-of-way, may utilize the existing surface streets at the two ends of the acquired block without change as local service ways. The ample intervening space may be used for a parklike development of the express way, which would be constructed on long, rolling grades to pass under bridges built at the street level of crossing and access streets and intervening pedestrian bridges, as pictured in plate X.

Except in the largest cities, it will probably not be necessary to extend express routes through the central business section. In the first place, it may usually be assumed that a substantial part of the traffic approaching the business section of a city is destined to that area, and will be discharged at its fringe, there to enter the central street system or a parking garage. In the second place, city-penetrating express routes, where they extend continuously across a city, can generally be located tangentially to the central business area. If and when it is necessary to extend an express route through a central business area, elevated or tunneled locations will usually be the more appropriate choices.

Legal Aspects of Limitation of Access

As indicated by the foregoing discussion, provision of the physical installations essential for limitation of access, though costly, involves few problems that have not been encountered in the design of ordinary main highways. The greater right-of-way requirements present more serious difficulties, and the present lack of special condemnation for the establishment of limited-access highways is a positive obstacle in many States.

The courts have recognized that abutting property owners have certain rights in existing streets and highways. These rights include the right of ingress to and egress from their property, and in some cases the right of visibility as well as the right to the flow of light and air from the street to the property. Moreover, it is well established in the common law that the right of access cannot be denied or restricted nor can an owner be deprived of such right except upon the payment of just compensation and in a manner not inconsistent with due process of law, and for a public use or purpose.

While there is a dearth of judicial opinion on the question of the abutter's right of access to newly created highway facilities, unless there is a reversal of judicial doctrine in many States the owner of abutting property is likely to possess the same right of access to new roads as he has with respect to old, established highways. The theory seems to be that the proprietary right of access of the abutter accrues as a matter of law the moment the new facility is opened to traffic. Granting that the doctrine of accessibility is logical in the case of existing highways, it seems unreasonable with respect to new through traffic facilities. Yet the concept of limited-access highways to facilitate the efficient movement of through traffic is of such recent emergence that the judiciary has not had the opportunity to endorse or reject it on its merits. It may well be that a crystallization of public opinion will constrain the courts to take a liberal view of the matter.

There are only 17 States [10] that now have on their statute books laws specifically sanctioning the establishment of limited-access highways. Bills designed to accomplish this purpose, which were introduced during the recent sessions of legislatures in 4 States,[11] failed of passage.

The availability and use of such specific authority for the denial of access where necessary is absolutely essential to a proper development of the interregional system in all States; and the necessary statutes should be enacted at the earliest possible date. As a guide to effective language for such enactments the Public Roads Administration has prepared a model limited-access highway bill, which incorporates the best features of the several existing statutes and contains all necessary provisions. This model bill is attached hereto as appendix III.

In the absence of a law clearly establishing the power of appropriate public authorities to create limited-access highways, an attempt, by negotiated compensation, to restrict abutters' rights of access to any section of existing or new highway could be obstructed by any unwilling abutter and probably by any other opposing individual or group. Without such a law the power of public agencies to extinguish private rights of access by condemnation would be in doubt and authority for the expenditure of public funds in compensation for such rights would be equally in doubt.

In 10 of the existing limited-access highway laws the State alone is given authority to establish such facilities. Since the necessity for limitation of access arises mainly in connection with the service of extraordinary volumes of traffic in and near urban centers, it is highly desirable that the power to create and participate in the creation of limited-access facilities be extended to city and county highway authorities, as provided by the recommended model bill.[12]

[10] California, Colorado, Connecticut, Florida, Illinois, Louisiana, Maine, Maryland, Massachusetts, Michigan, New Jersey, New York, Rhode Island, Texas, Virginia, and West Virginia (also enacted [illegible] session of November 1941).

[11] Nebraska, New Hampshire, Pennsylvania, and Wisconsin. All bills were pending in the legislature of Missouri, then in session, and in the legislature of New Jersey in recess until November 14.

[12] For a further discussion of [illegible] with illustrations of statutes, see Public Control of Highway Access and Roadside Development, by David R. Levin, Public Roads Administration, Federal Works Agency, 1943.

ACQUISITION OF RIGHTS-OF-WAY

The greatest single impediment to the timely realization of desirable road improvements has been the difficulty of securing the necessary rights-of-way. Too often in the past the character of road improvements undertaken has been governed by the limitations of short-sighted land-acquisition measures. When the acquirement of land is postponed, as usually it has been, until the very moment of need for construction purposes, it is often discovered that the land actually wanted cannot be obtained without long delay. Time pressing, plans are altered to require less or more-available land, and in the end it is often found that for such inadequate takings too much has been paid. Every condition leads to ill-advised and uneconomic compromise.

The causes of these conditions are mainly two: one, the failure to plan and provide funds for land purchases sufficiently in advance of the occasion for road construction, and the other the cumbersome and time-consuming land acquisition processes prescribed by the laws of most of the States. If work on the interregional highway system is to supply the post-war employment of which it is capable, and if design of the system improvements is to be unwarped by right-of-way considerations, both of these causes must be clearly recognized and remedied.

Funds for advance acquisition of right-of-way. The Federal Government has already made generous provision in the Defense Highway Act of 1941 and the recently enacted Public Law No. 146, Seventy-eighth Congress, for the survey and advance planning of highway construction projects. This provision can be, and is being, employed for planning of improvements on routes conforming to the interregional system. Without similarly adequate planning provision by the States and their subdivisions, the further need in remedy of the first of the causes mentioned is the early and sufficient appropriation of immediately expendable funds for acquisition of the necessary lands and rights-of-way. For this purpose the amendment of the Federal Highway Act by Public Law No. 146 is ineffectual.

Revision of land-acquisition laws. A complete remedy for the second of the causes referred to will require the more difficult revision of legally established methods of [illegible] in many States.

In 55 jurisdictions examined, the Committee has found that there are no less than 320 such methods in present use, with nothing inherent either in the nature of the governmental units exercising the power or in the public uses for which lands are acquired to require such varied treatment. The common defect of the majority of these varied methods is that they postpone the public possession of required lands until the compensation due private owners has been determined by processes which involve many possibilities of legal delay and obstruction.

Fortunately, however, there are among the methods in use a few, recently developed and closely similar in their essential requirements,

that avoid these delays, and yet afford ample protection of the rights of private property owners. Where these methods obtain, the condemning public authority, following required preliminaries, simply files a plat and description of the property to be acquired, and after notice to the owner of such action the appropriation is complete and title to the property vests in the State. If offers of the condemner are then rejected, the former owner must file a claim for the value of the property with the State court, which makes an award after hearing all the evidence.

The Committee recommends the general adoption of procedure of this type, details of which are well exemplified by methods now being employed pursuant to the New York Grade Crossing Elimination Act, pertinent sections of which are included in appendix IV. In the absence of some such provision, development of the interregional system will inevitably be slowed to long and costly ways not litigation, and public benefits of the needed facilities will meanwhile remain unrealized.

A classical illustration of the time that may thus be lost between the commencement of condemnation proceedings and the beginning of construction operations occurred in the widening of Woodward Avenue in Detroit. Delay of almost a year and a half was occasioned in this instance largely by the death of a juror, which invalidated the whole procedure and required a new trial to be instituted. The case cost the city of Detroit $100,000 and the public was deprived of the benefits that would have resulted from an early completion of the improvement. While other elements may have contributed to the delay, such as the very requirement of a unanimous verdict and determination of necessity by a cumbersome jury, indiscriminate adjournments and lack of supervision by the court, provision for early possession pending the action would have facilitated the completion of the project.

New express roads and private taxes. To convert existing highways to conformance with standards appropriate for the proposed interregional system will require much revision of alinement and in many sections a substantial widening of present rights-of-way. Where such required changes are numerous, the requirement of entirely new right-of-way will generally be found cheaper than widening and correcting the right-of-way of the existing road. The latter course will involve large takings of property frontage, always the most expensive of land acquisitions, and usually will entail also a heavy cost in incidental damages. The former, by avoiding existing frontage, will usually result in lower total costs notwithstanding the severance damages that may be involved. For example, it was estimated that the cost of land for widening the Albany Post Road in Westchester County, N. Y., from 66 to 166 feet would have been over $792,000 per mile, while for the Saw Mill River Parkway (of limited-access design) on entirely undeveloped new location and averaging 500 feet in width, cost only $138,600 per mile.

In and around cities the widening of existing rights-of-way is likely to be especially costly because of the high values usually attaching to urban street frontage and the improvements and structures characteristic of urban areas. For example, the widening of Ashland and Western Avenues and La Salle Street in Chicago cost more than a third of a million dollars per mile on the average for each additional

10 feet of width. In Detroit the property acquired to permit the widening of 3 miles of Woodward Avenue cost more than $9,800,000 of a total cost approximating $11,000,000, and the resulting functional improvement was very slight. In this case it has been estimated that the same total expenditure would have paid for 21 miles of limited-access highway constructed on a less expensive right-of-way with far greater results in the improvement of transportation service.

In each of these cited cases the additional width acquired at each side of the street to be improved was less than the full depth of abutting property lots. It is probable that the costs in these cases would not have been materially higher if the entire depth of abutting lots had been taken for as a general rule it is found that the acquisition of whole tracts of city property is seldom more expensive than the severing of a portion, because of the easy payment usually required for consequential damages to the untaken remainder.

Left in private hands the untaken portions of lots, odd remnants especially where they are very shallow or of other than rectangular shape can often be used only for the erection of billboards, shacks, or other unsightly structures. In many cases they remain as all-but-worthless vacant lots, valueless to their owners, but nevertheless preventing access to adjacent property which otherwise would enjoy useful street frontage.

The maximum width of right-of-way required for urban sections of the interregional system will generally be no greater than the depth of city property lots. Where such a width is to be taken it will be preferable, both for the avoidance of remnants and for the reduction of cost, to take the whole depth of a tier of lots on one side of an existing street rather than half portions of the lots on opposite frontage.

In most instances, however, the Committee believes that a fully adequate provision for city sections of the system will require the acquisition of a border-wide strip. As previously suggested, this will permit the retention of streets along the access lines as the essential local service ways of the express artery. It will avoid the scarring of the rear of properties, will isolate as much as possible the effect of depression and city encroachment for cars by leaving intact the bed of the flanking streets, if depressed, and will at the same time afford a sufficient width for adequate landscaping.

Land for margin protection and future road widening. On rural sections of the system, especially those sections which will be constructed initially as two-lane highways, the width of right-of-way acquired should be sufficient to provide for any surface widening that may be reasonably anticipated. Nothing is more conspicuously demonstrated by past experience than the costliness of successive acquisitions of property frontage to make room for repeated unanticipated road widenings.

The width acquired should also be sufficient to accommodate at each side of the roadway in its eventual anticipated width marginal strips of land to serve as a protection against the unsafe and unsightly development of closely crowding roadside stands, filling stations and signboards.

Unfortunately the expropriation of width additional to that required for the physical improvements immediately planned is

specifically sanctioned by law in only a few States.[15] Cases in which such [illegible] have not been clearly presented for judicial determination.

[illegible] constitute a "public use" in the narrowest sense of the term. A [illegible] unneeded remnants unavoidably acquired with the needed lands [illegible] in the statutes of Pennsylvania.[16]

As a better substitute for outright acquisition, the Committee [illegible] exists in a Maryland law enacted in 1941.[17]

Compensation for such rights would be nominal in most instances, [illegible] when land is being taken for immediate highway improvement

[15] California, Massachusetts, Michigan, New York, Ohio, Pennsylvania, Rhode Island, Virginia, and Wisconsin permit limited land acquisition by constitutional amendment.
[16] Purdon's Pennsylvania Statutes, 1949 (Perm. Ed.), title 36, ch. [illegible], sec. 61, pp. 51 et seq.
[17] Laws of Maryland, 1941, ch. 695.

often on new location in undeveloped areas. If the margins thus taken under control are later required for expansion of the road facility, as must inevitably be the case in many instances, the acquisition costs will be at a minimum because of the arrested development of the lands affected.

[illegible] which block the efficient acquisition of lands for highways likewise serve as impediments to the ready assembly of lands for other public purposes. Revision of the present laws and practices, if broadly conceived, can serve to remove the outmoded features of land acquisition for all public purposes with a single effort.

The Committee recommends, wherever possible, that lands needed for development of the interregional highway system be acquired in conjunction with the acquisition of lands for adjacent housing, airport, park or other public developments which the highways will be [illegible] and cooperative program of land assembly, the Committee believes, will be reflected in lower land costs, in a more rational land-use pat- [illegible] problems of such interrelated and mutually beneficial land acquisitions, the Committee recognizes a need for the creation of special land [illegible] or public purposes of any sort.

[illegible] the Public Roads Administration recommended the creation of such a land authority by the Federal Government. The Committee concurs in the recommendation. It also recommends the creation of similar land authorities by the States and by cities and legally constituted metropolitan areas, and suggests further that provision be made for the [illegible] under a Federal-aid plan which will enable the Federal agency to finance the acquisition of needed lands for highway and other public [illegible] cities over a long period of time.

[illegible] instrumentalities to assure the avoidance of conflict between the land acquisition purposes of public agencies devoted to various develop- [illegible] and supplementary measures of amortization.

[illegible] obstacles to the effective rebuilding of blighted areas at the cores of our great cities, an objective closely associated with one of the prin- [illegible] be said to be virtually insoluble without government financial and directive assistance.

[illegible] be used as an aid in the efficient assembly and appropriate redevelopment of large tracts of blighted urban lands, in reverse of the use of

such authority many years ago to subdivide and encourage the settlement of unoccupied primitive lands. The essential role of government in this connection would be to facilitate the transition financing of the rehabilitation of blighted areas, to employ its powers of eminent domain in the public interest, and to fix the standards of redevelopment. This role performed, the task of development and rebuilding according to the standards and master plan fixed should be transferred as largely and as promptly as possible to private initiative

PRINCIPLES OF LANDSCAPE DESIGN

Highway design in the broadest sense, rests upon landscape principles as well as upon the more commonly recognized engineering principles of alinement, profile, grade cross-section, roadway and right-of-way width, drainage, and structural strength and durability. A balanced agreement with the two sets of principles characterizes the best design

Flowing rather than abrupt change of gradient and alinement are necessary from the engineering standpoint for promotion of the safety and ease of vehicular movement and for increase in the highway's traffic discharge capacity. They are equally necessary to fit the road gracefully into its natural environment which is the essence of good landscaping.

Flattened slopes of excavation and embankment and a well-rounded cross-sectional contour are essential to prevent soil erosion and to minimize the risks of injury and damage when vehicles accidently or unavoidably leave the roadway They are needful also to mold the highway into the terrain and to make it a harmonious feature of the natural landscape

Marginal land strips, publicly owned or controlled, are required for the engineering reason of protection of vehicles moving on the highway against collision with entering vehicles, and of operators of moving vehicles against various roadside distractions. For landscaping reasons marginal land strips are needed to make possible a pleasing transition between the lines and plantings of the highway and the natural slopes and growth of the adjacent lands, to permit the screening of unsightliness, and to provide stopping space from which to view unfolded natural beauty.

If engineering principles require a certain monotony of smoothness and attention-lulling security in the roadway design, the appropriate application of landscaping principles can relieve the monotony and promote the safety of traffic by reawakening the interest and attention of drivers

The interregional highways, in their rural sections especially, will serve a traffic composed in large degree of vehicles driven in the pursuit of pleasure or recreation. Sound landscape design will increase the pleasure and relieve the strain of all journeys.

In their urban and suburban sections, the interregional routes will carry a heavy bustling traffic. Adequately landscaped borders will eliminate the traffic hazards of closely crowding buildings and insulate adjacent residential and business properties, churches, and schools from the noise, dust, and fumes of traffic.

Landscaping for rural sections of the system. Consideration of landscaping desiderata should pervade all stages of the location, design, and construction of rural sections of the interregional system, and a proper regard for landscape principles in the design will amplify and

increase the effectiveness of maintenance processes and lower the cost of adequate upkeep.

Without sacrifice of distance or economy it will often be possible to bring the highway into view of a lake or river, an interesting rock formation or wooded area. At no greater expense one location will provide frequent opportunities for distant vistas of natural charm that are unobtainable in an alternate location. For such enhancing investments as the interregional routes should be no sparing of whatever thought and care may be necessary to place these roads in locations of interest and fitness from every point of view, and this includes the fullest practicable development of scenic possibilities consistent with the primary requirements of traffic service.

In the location of a highway, due regard should be given not only to the width required for the present highway facility but also to that required for protective grass strip treatment and protection and enhancement of the view from the highway.

The former will provide the necessary screen between the highway and roadside activity of any character, whether space in which to screen from view unsightly or objectionable activity and space in which essential accessories, such as service stations, restaurants, wayside stops, and other necessary service facilities of an essential character.

The latter will provide the necessary space in which to screen the view of signboards and other unsightly objects to blend the road with the countryside, to locate parking strips and to provide vistas, overlooks and other buildings and resting places in attractive surroundings.

The planning of clearing operations should provide for the conservation of desirable existing vegetation and trees and the saving of topsoil to the greatest practicable extent, and the grading should provide the flattest lateral slopes and rounded contours that are necessary to mold the highway into its natural surroundings.

On two-lane sections the width of roadway and shoulders will be controlled by traffic requirements and by necessary cut-and-fill slopes or protective maximum grades at passing will limit the use of curvature for landscape effect. On such sections an ample right-of-way will usually afford adequate control to relieve the monotony of driving over long stretches of straight highway and will contribute largely to the safety as well as the comfort of travel. Under these conditions the value of land is likely to be relatively low and the need of a reserve of space for future road widening will supplement the requirements of appropriate landscape treatment and support the economy of a present land acquisition of right-of-way.

On divided, four-lane sections in rural areas, variation of the width of the median strip, a permissible more liberal use of curvature, and separate adjustment of the grades of the two roadways to the natural slopes of the terrain will add interest to the landscape treatment and often reduce the cost of construction. Where the location lies on the side of a hill or a ridge cross slope, for example, construction cost will usually be substantially lowered by locating the separate roadways at different levels and travelers on both roadways will have an unobstructed view of the countryside (see plate VII). A similar divergence in the alinement of the two roadways to take advantage of natural topographic conditions, such as location on the opposite banks of a stream or on the two sides of a local depression or rock outcropping, will likewise reduce costs and at the same time permit the conservation of interesting features of the natural landscape. And, even where there is no topographic reason for doing so, an opportune slight variation of the curvature of the two roadways will alter the width of the median strip and relieve the monotony of long parallel lines, without effect upon the total requirement of right-of-way width. An important result of all such variations in the lines and grades of the two roadways will be realized in reduction of the hazards of headlight glare in night driving.

As in the location and construction of the routes, design for utility and economy is found to go hand in hand with sound landscape design, so also a properly landscaped highway will be a highway easy to maintain. The flattened side slopes will favor the growth of vegetation, prevent erosion and thus remove the cause of much trouble in clogging of the drainage system. The cover slopes can be mowed by machine instead of by hand methods, and the streamlined contours of cut banks will reduce snow drifting and facilitate machine methods of snow removal.

It will be observed that there has been no mention in the foregoing of the tree planting that is so widely associated with the idea of roadside improvement. The omission has been intentional. There is no place in sound rural highway landscaping for the regular or row planting of trees. The objective should be the preservation or, where necessary, the re-creation of a natural foreground environment in harmony with the distant view. To that end existing native trees and beautiful groups should be preserved wherever possible, and unpleasing and view-obstructing growth should be removed, and only where natural trees and other growth will serve to highlight the natural beauty of the roadside view or wherever necessary to be able to screen unsightly or distracting objects or activity should the replanting of trees receive consideration. Trees replanted for such reasons should be invariably native to the environment.

The landscaping of urban sections.—In cities and their nearer suburban areas the opportunity for the development of balanced treatment will be more limited. The requirement of straightness of right-of-way alinement there necessary for avoidance of conflict with the existing street plan and of confining the approaches of the interregional routes to rigidly straight lines. Within a block-wide right-of-way the separate roadways may be constructed at different levels in adaptation to an existing transverse slope. The grades of both roadways may be gracefully rolled, dipping across and bridges at the cross streets alternating between the two roadways, to suit the grades of the existing streets which form the local service ways. As they rise and fall the separate roadways may be caused to diverge and converge in alinement, thus varying the width of the median strip. Or the two roadways may be swung to one side of the right-of-way with only a narrow median strip intervening there, for example, to pass under a crossing bridge located off center with respect to the right-of-way. To gain space for occasional widenings of the median strip or lateral park areas, retaining walls may be used to reduce the width required for slopes in depressed sections, but these should preferably be constructed at the edge of the service ways and never in cramping proximity to the roadways of the express route. The widened central or lateral areas may be used for appropriate plantings or for rest or playground areas

approached by pedestrian bridges or by steps from a crossing bridge or street. A treatment of this general character is suggested in plate X.

On urban sections of the routes the planting of trees in formal arrangement will be more appropriate than on rural sections. A tree screen may be used to separate the highway from an adjacent railroad freight yard or industrial siding or to conceal other unsightly or objectionable roadside conditions. Trees in formal arrangement may be set against the straight lines of the local service ways to insulate bordering residential property from the restless movement of traffic on the expressway. But everywhere the effort should be made to avoid monotony and tiresome sameness in such plantings over long stretches of the routes.

Small flowering trees and vines may be appropriately set in the wider median or lateral areas and on the side slopes of depressed sections to vary the sameness of long stretches of uniform turfed banks. And every section of retaining wall at crossing bridges and against the occasional cuts will offer opportunity for attractive groupings of small flowering trees, masses of shrubs, roses, and other low-growing plants in suitable relation.

All these things may be done in complete consistency with the utilitarian functions of the expressways. And, so treated, these new arterial ways may be made—not the unsightly and obstructive gashes feared by some—but rather elongated parks bringing to the inner city a welcome addition of beauty, grace, and green open space.

STANDARDS AND FEATURES OF ROADWAY LOCATION AND DESIGN

Any network of highways that may hereafter be designated officially as an interregional system should embrace as nearly as practicable, with such modifications of mileage adopted and subject to the necessities of national extension and interconnection, those general routes along which the heaviest traffic moves or is likely to move in each region traversed. It has been the Committee's aim to select such a system and it believes that, insofar as its necessarily limited studies have permitted, it has made this selection in the system recommended in this report. This network, or a better system selected after more complete study, should be consistently constructed throughout, in all parts of the country, as a well-balanced whole, in the post-war years ahead.

There are existing roads that conform closely to all parts of the recommended system. There will be existing roads conforming more or less closely to any system that may be selected as a better modification of the system recommended. After any such system is finally agreed upon, whenever the improvement or reconstruction of any section of conforming highway is contemplated, it should be built on a location and to a standard of design that will make it a fit and lasting part of the complete interregional system that will be created by such sectional increments.

This incremental construction will be carried out under various auspices. In part, doubtless, it will be done by the Federal Government and States jointly; in part, by the States alone; in part by combined Federal, State, and city effort; in part by State and city cooperation and possibly in part upon the completely independent initiative of cities. If built in this manner, the interregional system is to achieve the high degree of consistency of design and utility that is desirable two arrangements are necessary. First there must be an agreement upon certain basic standards of roadway design and location, by all authorities likely to have a share of responsibility for its construction. Second, there must be a determination on the part of these authorities and the public that whatever work at any time is done on routes generally conforming to the selected system shall be well done in accordance with the agreed standards. In no other way will it be possible to achieve the timely completion of a consistently useful and wholly satisfactory interregional highway system.

To this end the Committee proposes herein certain basic standards for general adoption. It recommends that these standards be widely considered by all possible cooperating authorities and that after there has been sufficient opportunity for such consideration, occasion be made at the initiative of the Public Roads Administration to effect agreement as complete and general as possible upon these or other acceptable standards. The Committee recommends further that the agreed standards be made the required basis of any cooperation on

the part of the Federal Government in the construction of any route conforming to the interregional highway system as it is finally designated

Prefatory to the standards proposed, the Committee offers the following fundamental recommendations

1. The interregional highway system, as it is hereafter constructed or improved, shall provide or allow for the subsequent provision of facilities capable of serving safely and efficiently a mixed traffic of passenger automobiles, motor busses, and motor trucks, and tractor-trailer and semi-trailer combinations, of a volume of each of the constituent elements estimated to be that which will exist 20 years from the date of construction

2. All roadways and structures built on the interregional system shall provide either in the immediate design or feasible modification thereof, for the passage and support of vehicles and combinations of vehicles of the following dimensions and weights, in the frequency and distribution of such dimensions and weights to be expected 20 years from the date of construction

Width	96 inches
Height	12 feet
Length over-all, including bumpers and load:	
Single vehicles	35 feet
Tractor-semitrailer combinations	50 feet
Other combinations	60 feet
Axle load [1] on pneumatic tires	18,000 pounds

[1] Defined as the total load on all wheels whose centers may be included between 2 parallel transverse vertical planes 40 inches apart.

Gross weight on any vehicle or combination of vehicles according to the formula

$$W = C\,(L + 40$$

In which

W = gross weight of vehicle in pounds.

L = length in feet between the foremost and rear axles of the vehicle or combination of vehicles or any group of axles thereof.

C = A coefficient with the following values

For values of L less than 18 feet	650
For values of L equal to or greater than 18 feet	750

3. For purposes of the design of highway facilities and the application of standards and conditions hereafter recommended, all sections of the interregional system in or approaching a city or town and at least 1 mile long, along which intersecting roads or streets average one-quarter mile or less apart, shall be considered as urban sections, regardless of their locations within or without the corporate limits of cities. All other sections of the system shall be considered as rural sections, regardless of their location within or without the corporate limits of cities

4. All rural sections of the system shall be designed at all points and in all respects for safe travel by passenger vehicles at a speed of not less than 75 miles per hour, and by trucks and tractor combinations at a speed of not less than 60 miles per hour in flat topography In more difficult terrain the speed for which the highway is designed may be reduced; but in no case to less than 55 miles per hour for passenger vehicles and 35 miles for trucks and tractor combinations in mountainous topography. All rural sections shall provide a sufficient number of passing lanes and other facilities so that at no time, except during infrequent peak hours, will it be necessary because of the interference of other vehicles to reduce the average running speed to less

than 50 miles per hour. All two-lane rural sections, on which the sight distance provided will not permit safe passing at the above design speed for passenger vehicles, shall be appropriately and conspicuously marked as no-passing zones or as zones in which passing is unsafe.

5. All urban sections of the system shall be designed at all points and in all respects for safe travel by passenger vehicles at a speed of not less than 50 miles per hour, and by trucks and tractor combinations at a speed of not less than 35 miles per hour. All urban sections of the system shall provide a sufficient number of lanes and other facilities so that at no time, except during infrequent peak hours, will it be necessary because of the interference of other vehicles to reduce the average running speed to less than 40 miles per hour.

6. Wherever financially feasible, the system shall provide continuous lateral space and adequate support for standing and disabled vehicles of the recommended maximum sizes and weights, clear of the road surface or pavement.

7. All road surfaces, pavements, and structures on the system, when maintained with a reasonable expenditure of effort, shall be capable of supporting vehicles of the recommended weights without reduction of either weight or speed at any season of the year.

Consistent with the foregoing fundamental recommendations, the Committee proposes for general adoption, basic standards of road and structural design, applicable to the selected interregional highway system. These basic standards are contained in appendix V

CONSTRUCTING THE RECOMMENDED INTERREGIONAL SYSTEM

In considering the actual construction of the interregional system in accordance with the foregoing principles and the standards in appendix V, several elements need to be taken into account, such as those discussed in the concluding pages of this report.

Condition of Existing Roads, Streets, and Bridges

Measured by the standards recommended for the interregional highway system, very few of the existing rural roads and almost none of the city streets which conform approximately in location to the recommended system are adequately improved. Less than 1 percent of the bridges on these rural roads closely approximate the standards proposed.

The only urban facilities approaching the proposed standards that are known to exist on routes of the recommended system are the Cahuenga Pass and Ramona Freeways in Los Angeles; the Oakland Express Highway in St. Louis, the Lakefront Freeway in Cleveland, the Pulaski Skyway in Newark and Jersey City, N. J.; the West Side Elevated Highway, West Side Improvement, Henry Hudson Parkway, and East Side Drive in New York City; and the Saw Mill River, Cross County, and Hutchinson River Parkways in Westchester County, N. Y.

On the more heavily traveled of existing rural roads approximating the recommended system, the only improvements that are known to approach the proposed standards are the Willow Run Expressway System and Detroit Industrial Expressway in Michigan and possibly the Taconic State Parkway in New York, all of which are toll-free, and the Pennsylvania Turnpike in Pennsylvania and the Merritt and Wilbur Cross Parkways in Connecticut, each of which is now operated as a toll road.

Each of these toll facilities conforms approximately to a route of the recommended interregional system, and each meets substantially the requirements of standards proposed for the system. The Committee recommends that they be incorporated in the system after appropriate measures have been taken to abrogate the present collection of tolls.

The Pennsylvania Turnpike extends for 160.7 miles from Middlesex near Harrisburg to Irwin near Pittsburgh. If it is taken into the interregional system, the number of access points or interchanges on this route should be increased.

The Merritt and Wilbur Cross Parkways extend for about 42 miles from a connection with New York's Hutchinson River Parkway to a point northeast of Milford, Conn. No change is required in the present design of these facilities to make them acceptable parts of the interregional system.

Other than the sections mentioned, there are few if any of the more heavily traveled existing highways approximating in location the routes of the interregional system, that approach in their present state the standards proposed for the system. On most of these nonconforming heavily traveled roads, there is present need for major improvement which would generally be associated with those features of design essential for the provision of free traffic flow and only to a lesser degree with the structural quality and condition of pavements.

Among the more lightly traveled of existing highways approximating the location of sections of the system, substantial conformity to the less exacting standards proposed for such sections of the system is more common. But of these more lightly traveled highways, even a large mileage cannot be regarded as an acceptable addition to the system without major improvement—improvement which again involves the provision of features of free traffic flow to a greater extent than the provision of adequate road surfaces.

CONDITION OF ROADS

Surfaces or pavements.—Regarding the condition of the existing rural roads, the nearest approach to any particular of the recommended standard of adequacy is reached in the character of the surfaces or pavements, as shown in table 16 which records the type of surface improvement existing in 1942 in relation to traffic densities. Of the rural roads included only 60 miles were unsurfaced. Untreated gravel and stone surfaces existed on only 168 miles or 0.6 percent of the total rural mileage. All other sections of the rural roads included were improved with some form of dustless surface or pavement, ranging from bituminous surface-treated gravel or stone surfaces to the highest types of pavement.

TABLE 16.—*Mileage, mileage by traffic density groups, and percentage of total mileage of rural sections of the recommended interregional system improved with various types of surface in 1942*

	Surface type							Total
	[illegible]	[illegible]	[illegible]	Mixed bituminous	Bituminous surface treated	Gravel or stone	Unsurfaced	
[illegible]	[illegible]	[illegible]	[illegible]	8,247	2,074	168	60	[illegible]
[illegible]	[illegible]	[illegible]		28.0	7.0	0.6	0.2	100
	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles
[illegible]			[illegible]	4,245	[illegible]	[illegible]	45	[illegible]
[illegible]	[illegible]	[illegible]		2,954	[illegible]	25	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	[illegible]	[illegible]			2			[illegible]

Bituminous-treated surfaces existed on 2,074 miles or 7.0 percent of the total rural mileage; mixed bituminous surfaces on 8,247 miles or 28.0 percent of the total mileage, and bituminous penetration surfaces on 1,772 miles or 6.0 percent of the total mileage. Lengths

totaling 2,488 miles or 8 5 percent of the total rural mileage were paved with bituminous concrete or sheet asphalt pavements, and 14,602 miles or 49 6 percent of the total were paved with concrete, brick, block, or some combination of high-type pavements.

In general design at least, there is a marked correlation between the surfaces and pavements of the existing roads and the volume and weight of the traffic they serve Grouping untreated gravel and stone surfaces as low types; bituminous surface-treated gravel and stone, mixed bituminous surfaces, and bituminous penetration surfaces as intermediate types; and bituminous concrete, concrete, brick, and block as high types, the sections of the system improved with each of these classes of surfaces are indicated by type symbols in the map figure 32 Comparison of this map with the traffic map presented as figure 20 will confirm the statement that there is a strong correlation between the existing surface types and traffic volume.

Inadequacy of design.—But while the existing roads may be said to be reasonably well improved so far as the character and strength of their surfaces are concerned, they are far from adequate in respect to those characteristics of their design that have a bearing upon their ability to discharge their traffic without congestion These characteristics are the width and lane arrangement of the surfaces or pavements, gradients and curvature, and the related characteristic of sight distance.

To obtain the additional width and lane arrangement required for conformity to the recommended standards will necessitate almost universal widening.

Here we encounter the deplorable fact that existing rights-of-way are grossly insufficient to permit such widening

Even, therefore, if it were possible to attain the recommended standards of design without change of existing alinement, a right-of-way problem of great difficulty would be presented, and the fact is that the faults of curvature and gradient are so numerous that no approximate compliance with the proposed standards can be achieved on most sections without wide departure from the existing alinement.

Taken together, the two circumstances of insufficient width and inadequate alinement, if the proposed standards are to govern, leave little choice in most sections of the system other than the obtainment of entirely new right-of-way, and this conclusion, reached from the consideration of essentially dynamic qualities of the highways, agrees with the decision that must inevitably result from any consideration of a desirable directness of routing between the principal sources and objectives of interregional highway traffic.

Bearing out the foregoing general statements, figure 33 presents a graphical analysis of the average physical conditions of existing rural roads conforming approximately in location to routes of the recommended system, classified according to the average daily volume of traffic. From this figure it will be seen that the most lightly traveled roads conforming to the system are those that approach most nearly the standards proposed

FIGURE 32.—Classes of surface improvement on existing roads, corresponding approximately to routes of the recommended interregional system

Roads carrying less than an average of 1,000 vehicles per day average 20 feet in surface width, or 4 feet less than the width recommended for interregional highways of such traffic volume. The choice of surface type for these roads is generally consistent with the traffic served. The frequencies of occurrence of sharp curves, steep grades, and consequent restricted sight distances as a group average less for these most lightly traveled roads than for most of the heavier traffic-volume groups, and the existing right-of-way provided is more nearly adequate.

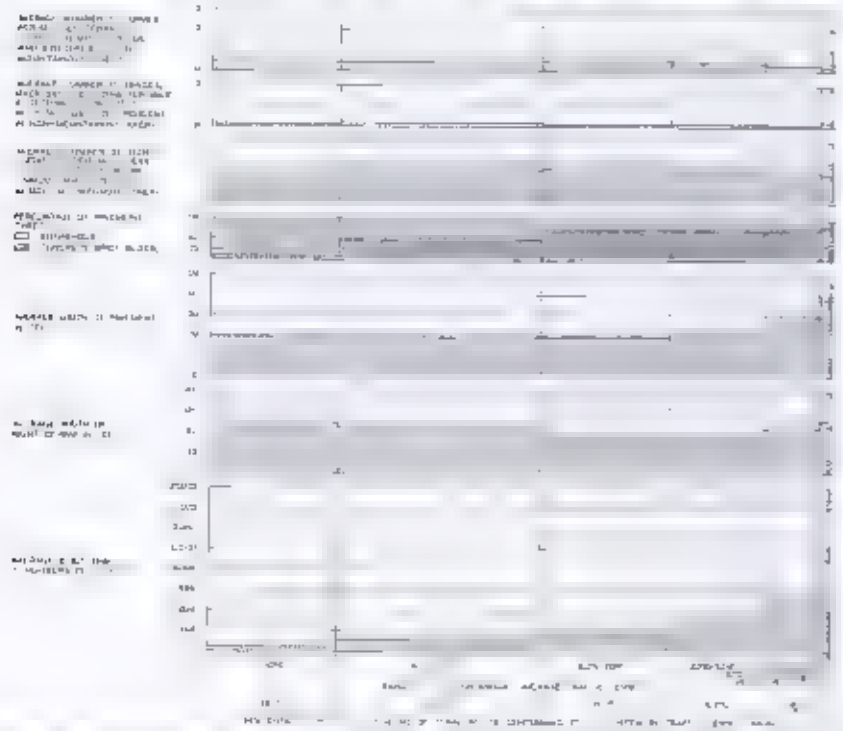


FIGURE 33.—Average physical conditions of rural sections in the recommended system classified according to [illegible] average [illegible] volumes

The close approach to adequacy existing on these lightly traveled roads results principally from three circumstances. First, many of the routes included are in sections of the country where most roads follow the straight lines of land sections established by the Government; second, many are located in sparsely settled rural areas of easy topography where the obtainment of reasonably satisfactory alinement and wide right-of-way has been a comparatively simple matter; and third, they generally received their initial improvement at a later date than the more heavily traveled roads and benefited in that improvement by more modern standards of design.

The relative adequacy of these lightly traveled sections, however, only serves to throw into stronger relief the grave inadequacy of the more heavily traveled sections, especially in right-of-way and pavement width and sight distance.

The group of roads serving traffic between 2,000 and 3,000 vehicles daily, a density for which the recommended standards would require the provision of four traffic lanes in the presence of restricted sight distance, is shown to have on the average more numerous restrictions of sight distance than the most lightly traveled sections, and surfaces of the same average width as the most lightly traveled sections.

In the groups carrying average daily traffic between 3,000 and 10,000 vehicles for which divided four-lane pavements are recommended throughout there is some evidence of a beginning of widening, still far from adequate; and even the most heavily traveled sections, carrying traffic in excess of 10,000 vehicles daily, average less than the desirable four-lane width and have these inadequate widths cramped within rights-of-way so narrow as to prohibit the essential widening.

A substantial mileage of the wider roads that account for the greater average widths of sections carrying upward of 3,000 vehicles per day, as shown in figure 33, are surfaced with three-lane and four-lane, undivided pavements. These types of improvement, largely employed as expedient measures in the thirties, have no place among the standards recommended by the Committee for the interregional system. Table 17, however, accounts for 1,364 miles of three-lane and 1,181 miles of undivided four-lane pavements in the total of 3,451 miles of pavement wider than two lanes that existed in 1942 on the highways conforming approximately to the interregional system, and shows that only 906 miles of these roads were then improved with divided four-lane pavements and pavements more than four lanes wide.

TABLE 17.—*Mileage of rural highways conforming to the recommended interregional system, on which multiple-lane pavements were completed or under construction Jan. 1, 1942, classified by traffic volume groups*

Traffic volume group	Number and arrangement of lanes				
	3 lanes (undivided)	4 lanes (undivided)	4 lanes (divided)	More than 4 lanes (divided or undivided)	Total
Vehicles per day	Miles	Miles	Miles	Miles	Miles
[illegible]	80	1,[illegible]5	[illegible]85	16	[illegible]48
[illegible]	[illegible]4	[illegible]36	[illegible]		29 97
[illegible]	[illegible]	83[illegible]6	[illegible]49	1[illegible]73	2,462 86
[illegible]	[illegible]	23[illegible]4	[illegible]	3[illegible]90	392 39
Total	[illegible]63	1,[illegible]5[illegible]4	84[illegible]5	5[illegible]87	3,451 39

It will be observed that four-lane pavements have been provided on a comparatively small mileage where the traffic volume is less than that proposed for general design of that width. Three-lane pavements on other sections serve a traffic greater than that proposed by the Committee as a criterion for four-lane divided design and considerably greater than that served by other sections on which four lanes have been provided.

It will be noted also that some sections of undivided four-lane design serve traffic of greater volume than that for which divided four-lane accommodation has been provided on other roads.

The fact that much of the mileage classified as providing three, four, or more lanes does not actually provide the number of lanes

indicated in lanes of adequate width is not brought to light by table 17. It is nevertheless true that a part of the mileage indicated as having four lanes is actually paved only 36 feet wide and provides, therefore only three lanes of the width recommended by the Committee; and, similarly some of the three-lane mileage shown as existing is little wider than the width of two lanes of the dimension the Committee recommends.

Assuming adoption of the criterion recommended for the general provision of four or more lanes (viz, average daily traffic exceeding 3,000 vehicles), figure 34 shows the sections of the recommended system that should be improved with pavements of four or more lanes and in comparison shows the existing provision on roads conforming to the system. As will be observed, there are many sections where the greater capacity of four lanes is recommended but where the existing road conforming to the system provides only two or three lanes. On the other hand, a few sections of four-lane pavement shown as existing are located on roads which, according to the recommended criteria, require only a two-lane pavement for adequate improvement.

CONDITION OF CITY STREETS

In the foregoing it has been possible to present a picture in some detail of the physical condition of existing rural highways conforming approximately in location to parts of the recommended system. Of the city streets now serving as connections between the rural highways approximating the system, it is possible to give no similarly detailed account. Judged by the standards proposed, however, existing facilities provided by city streets are so far from adequate that there is little need for detailed analysis.

Like the rural roads, existing city streets approach nearest to adequacy in the design of their pavements, but a widespread neglect of maintenance has permitted much deterioration of what would otherwise remain as structurally adequate surfaces. In relation to their traffic volumes, many of the city streets have an over-all width less than that provided on some of the rural roads; and, with curb parking a prevalent condition, the width effective for the accommodation of moving traffic commonly compares unfavorably with the corresponding clear width of rural roads.

Intolerable congestion in recent years has forced some effective enlargement of street capacity by the prohibition of parking and the marking of one-way streets. Some minor widening of the vehicular roadways has been achieved also by borrowing slightly from the width of sidewalks. In a few notable cases, such as Woodward Avenue in Detroit and Constitution Avenue and others in Washington, D. C., broad surface streets have been created by the more heroic means of large-scale property demolition and new right-of-way acquisition.

But instances are rare indeed in which the congestion of through highways in cities has been attacked at its principal root—the frequent grade intersection of cross streets. Instead of eliminating this principal cause of traffic delay, city authorities have generally resorted to the installation of traffic lights for control of the intersecting traffic streams and the prevention of accidents, and this expedient measure has in some cases been so applied as to increase rather than reduce the obstruction of traffic.

FIG. 34.—Sections of existing rural roads conforming approximately to the recommended interregional system that require divided four-lane pavements, pavements recommended standards; and the location of four-lane pavements, divided and undivided, that existed in 1942.

CONDITION OF BRIDGES

Design loading.—On the 29,450 miles of rural roads approximating the location of routes of the recommended interregional system there are 8,435 bridges. Seven hundred and twenty of these bridges are designed for loading inferior to the H15 standard loading of the American Association of State Highway Officials. The greatest number, 7,040 [illegible] are designed for loadings equivalent to the H15 standard loading or superior to the H15 standard loading. Only 675 are designed for the H20 standard loading, and of these 151, the spans of which are 26 feet or less in length, may be considered as adequate for the support of the H20 standard loading reconstructed for bridges to be constructed on the interregional system. This classification however is based [illegible] on the less [illegible] existing structures and takes no account of [illegible] depreciation. Although no available [illegible] permit a statement [illegible] it is probable [illegible] bridges originally designed for H15 loading, by reason of deterioration, are not now safe for the support of [illegible] standard [illegible] loadings.

Horizontal clearance.—In table 18 the numbers of existing bridges having horizontal [illegible] of various [illegible] are given in relation to [illegible] and widths of [illegible] which the bridges are carried. Total [illegible] width of the [illegible] existing bridges [illegible] or more [illegible] percent curve or [illegible] [illegible] feet [illegible] than half of [illegible] on roads [illegible] 20 feet or more in width.

Of the widest bridges—those with horizontal clearance of 60 feet and [illegible] here [illegible] percent are located on roads which [illegible] existing [illegible] surfaced with only two lanes of more or less adequate width.

TABLE 18.—*Classification of all existing bridges on rural roads conforming to the recommended interregional system according to several ranges of horizontal clearance* [illegible]

Total width of approach highway surface	Number of bridges classified according to horizontal clearance								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total
Undivided roadways									
Total [illegible]	553		38	256	37	1	5		2,865
20 feet [illegible]	6		278	826	40	346	87	5	4,262
24 feet [illegible]	61	8	8	60		4	1		267
26 to 27 feet		3		2					45
28 to 29 feet				10					60
30 to 32 feet	1	1	5	66		6		4	24
36 to 38 feet		29	54	35		19	1	4	322
40 to 42 feet				3				2	10
44 to 46 feet				1					2
48 to 50 feet									1
60 to 62 feet					4	4			8
Total undivided	61	41	2	74	80	40		5	7,598
Divided roadways									
40 to 45 feet						4	6	62	286
47 feet						1		1	8
50 to 54 feet									1
57 to 58 feet									1
59 to 62 feet				1	2			4	30
62 feet and over								1	2
Total divided	3	5	3	6	2	45	7	79	328
Total undivided and divided	64	46	5	80	48	85	12	84	8,435

Approximately 970 of the 8,435 bridges, or more than 11 percent, afford horizontal clearances less than the surfaced widths of the existing roads on which they are located, and on only about 4,340, approximately half of the total number, is the horizontal clearance afforded as much as 4 feet wider than the existing surface of the approach road.

Even in relation to the existing road widths, which, as previously shown, are generally deficient, the clearance of existing bridges will be seen from this analysis to be far from satisfactory. Measured by the standards recommended by the Committee the situation is much worse.

Of the total of 8,435 bridges, 6,466 are located on roads carrying less than 3,000 vehicles per day, for which the standards proposed provide generally for improvement with two-lane pavements 24 feet wide. Of these 6,466 bridges 2,289 are 100 feet or more in length and, according to the standards proposed, should have horizontal clearance of 30 feet. Only 202 of the 2,289 bridges meet this requirement. The remainder of 4,177 bridges, which are less than 100 feet in length, to meet the standards proposed should have horizontal clearance of 44 feet, but only 112 of them as presently designed meet this requirement. In sum, therefore, only 314 of the 6,466 bridges now existing on roads approximating sections of the system which are designed as 24-foot, two-lane highways, conform to the standard of horizontal clearance proposed as desirable by the Committee.

On roads conforming to the system, which now serve volumes of traffic between 3,000 and 15,000 vehicles per day, there are 1,911 of the total of 8,435 bridges. For these roads the recommended standards require four-lane divided highways. Of these 1,911 bridges, 771 are 100 feet or more in length and for these the proposed standards require a horizontal clearance of at least 58 feet. Only 26 of the 771 bridges meet this requirement. The remainder of 1,140 bridges which are less than 100 feet in length, require, according to the proposed standards, horizontal clearance of 56 feet, a requirement which is met by only 17 of the existing bridges. Of the total of 1,911 bridges on roads carrying traffic of between 3,000 and 15,000 vehicles per day, therefore, there are only 43 that meet the standards of horizontal clearance proposed by the Committee.

Finally, there are 58 of the 8,435 bridges on roads now carrying traffic in excess of 15,000 vehicles per day for which six-lane highways are required. Thirty-three of the 58 are 100 feet or more in length and, according to the standards proposed, should have horizontal clearance of 82 feet. Twenty-five are less than 100 feet long and should have horizontal clearance of 104 feet to meet the proposed standards. None of these bridges meets either of these requirements.

From the above analysis, therefore, it is apparent that only 347, or 4.1 percent of the total of 8,435 bridges, conform in their present design to the standards of horizontal clearance proposed by the Committee for bridges on the interregional system. To conform to these standards all the rest would have to be widened in amounts varying from a few to more than 70 feet.

Vertical clearance. The situation in respect to vertical clearance is much better. Of the total of 8,435 structures on all existing rural roads approximating the recommended system, there are 8,410 which as presently designed are either unlimited in vertical clearance, or provide at least the 14 feet proposed for structures on the system. Of those that do not meet this standard, 15 provide vertical clearance

of 13 feet, enough with a slight margin to pass vehicles of the 12½-foot height recommended as a maximum. Only 10 of the existing structures provide definitely inadequate vertical clearance.

Combined standards.—In many cases the existing bridges that are substandard in respect to horizontal or vertical clearance, or both, are also substandard in respect to load design. Of the 8,088 bridges that fail to meet the recommended standards of horizontal clearance, 7,445 are inferior in loading design to the H20 standard. Of the 347 bridges that meet the recommended standards of horizontal clearance, only 72 are designed for H20 loading.

These 72 bridges also provide the recommended 14-foot vertical clearance and are therefore the only bridges now existing on the entire mileage of rural roads conforming to the recommended system that closely approximate the standards proposed.

Next in adequacy are the remaining 603 bridges designed for H20 standard loading. All but 2 of these provide the recommended vertical clearance, but are more or less deficient in horizontal clearance. Two hundred and ten of them are long bridges (100 feet or more in length), with [illegible] clearance varying from less than 5 to more than 50 feet. Three hundred and ninety-three are short bridges (less than 100 feet long), which are deficient in horizontal clearance by amounts varying from less than 5 to more than 70 feet. One hundred and sixty-six of the long bridges and 376 of the short bridges are of truss type construction. These, where they are not greatly deficient in width, can be widened with comparative ease.

Desirable Order and Rate of Construction

It will be apparent from the previous section on condition of existing roads, streets, and bridges that there is immediate need for a vast amount of new construction to replace inadequate facilities with the far superior facilities described as appropriate and essential for the interregional system. The need as here suggested arises more from deficiencies in the alinement, width, and access features of the existing roads rather than from inadequacies in the structure of existing surfaces and pavements.

Many of the existing roads are improved with surfaces and pavements of comparatively recent construction and with normal maintenance, these will have a further serviceable life, under the traffic to be expected, of from 10 to 20 years. Where this condition exists, and other features such as curvature, gradient, width, sight distance, and intersection design are not seriously deficient in relation to the traffic carried, the present roads can reasonably be continued in use until either the existing pavement has served out its economic life or the traffic has increased to such a density as to compel improvement.

Principle of minimum rate and indispensable order of construction.—Obsolescence of the existing roads will thus determine a minimum rate at which the interregional system should be constructed, and it may be stated as a general principle, that—

Whenever an existing highway conforming approximately to a route of the interregional highway system shall require reconstruction, by reason of the deterioration of its surface or other incapacity, the highway should be reconstructed only in the location and to the standard

of design necessary to make it an acceptable link in the designated interregional highway system.

Compliance with this principle, it is emphasized, will establish only a minimum rate and indispensable order of construction of the system.

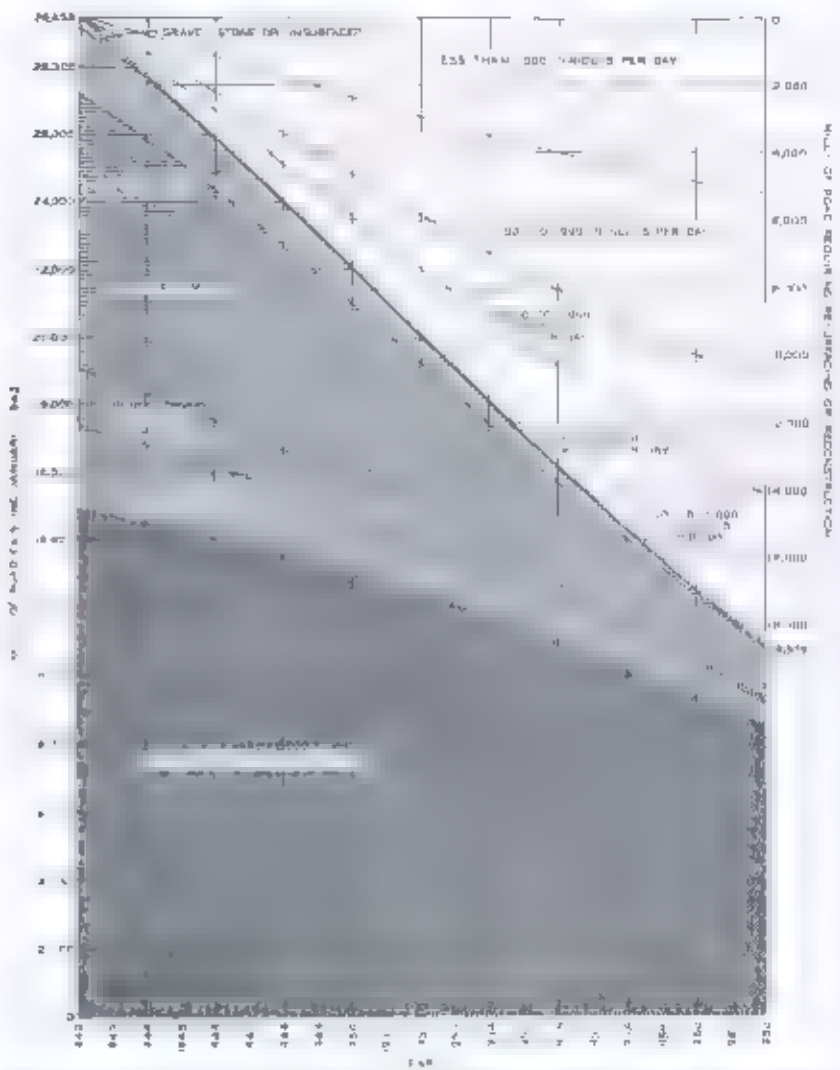


FIGURE 32.—Graph showing approximate, by years, of surfaces existing on [illegible] roads conforming up to the interregional system, and of traffic density classes of roads [illegible] probably will require reconstruction by years.

It will doubtless be desirable to exceed this minimum rate and depart from the indispensable order to realize earlier the benefits of safe and unobstructed traffic flow which construction to the proposed standards will insure, and, particularly in the immediate postwar period, "to utilize productively some of the manpower and industrial capacity then available in accordance with the President's farsighted objective

An approximate evaluation of the minimum rate at which the rural sections of the system should be constructed can be made by determining the probable economic life remaining in the surfaces and pavements of existing highways conforming approximately in location to routes of the system.

Figure 35 shows by the differential segments of the 1942 ordinate, the mileage classification of the various types of surfaces and pavements existing on highways conforming approximately to routes of the recommended system on January 1, 1942. The width of the shaded band [illegible] from one end of these segments shows by the intercept at each subsequent annual ordinate the approximate mileage of the several types of surfaces and pavements existing on January 1, 1942, that will remain in service [illegible] January 1 of each of the several years. The open space portion of the diagram shows similarly the 1942 traffic-density classification of the mileage on which surface or pavement reconstruction will have become necessary by January 1 of each year.

The mileage of surface or pavement reconstruction indicated by the depth of the open section of the diagram according to the scale at the right as likely to become necessary by January 1 of each year includes only the reconstruction of the surfaces or pavements existing on January 1, 1942. During the period of 20 years covered by the diagram, it is probable that some of the less durable surfaces constructed in replacement of existing surfaces will themselves become subject to the point of structural reconstruction. This will depend upon the durability of surfaces and pavements constructed on the interregional system, and the amount of secondary reconstruction that will become necessary during the period will be reduced to a minimum only by a policy of liberality in the selection of surface types for interregional system improvements.

If, in any period, as during the present war emergency, reconstruction becoming due is deferred, the amount essential will accumulate and when the opportunity occurs it will be necessary to provide for an enlarged program of reconstruction to be continued for a period sufficient to meet the accumulated need.

For example, very little of the reconstruction indicated as of probable necessity by January 1, 1944, is now being accomplished.

Accordingly, as the diagram shows there will have accumulated by the beginning of 1944 a need for the reconstruction of surfaces or pavements on about 1,700 miles of highways conforming approximately in location to routes of the recommended system and this mileage will be distributed, 350 miles on sections which in 1941 carried a daily average of 3,000 but less than 10,000 vehicles, 300 miles on sections that carried between 2,000 and 3,000 vehicles, 500 miles on sections that carried between 1,000 and 2,000 vehicles and 550 miles that carried in 1941 a daily traffic averaging less than 1,000 vehicles.

If the period of deferment should extend to January 1, 1945 or 1946, the total accumulated reconstruction need might be increased to 2,650 or more than 3,500 miles, respectively.

These estimated accumulated reconstruction needs are for rural sections only. They represent needs accumulated by the obsolescence of surfaces and pavements only and take no account of the greater needs of reconstruction to provide for safe and unobstructed traffic flow. They must be regarded, therefore, as minimum needs.

It is desirable to emphasize that the surfaces and pavements on the sections of existing highway involved in these estimates will probably be in absolute need of replacement by the dates indicated. They must and will be replaced in some manner as soon as possible after these dates, if economic and other conditions permit.

The Committee has at its disposal no data that will permit for urban sections of the system an appraisal of minimum construction needs similar to the foregoing estimate for rural sections. It must be recognized, however, that the pavements of major city streets are accumulating replacement needs in the same manner as the surfaces of rural roads, and that the meeting of these needs is for the same reasons at present deferred but will be taken care of as soon as it becomes possible to do so.

Planning the Construction of the Interregional System

If the recommended interregional system is not officially designated and the proposed standards accepted—if, in other words, the relation of the sections of existing highway to a particular system of interregional routes is not recognized—before the existing obsolescent surfaces and pavements are renewed, it is probable that the reconstruction will be planned and carried out on locations and in a manner inconsistent with an eventual adequate development of the interregional system. This, if it should occur, would constitute a regrettable misapplication of available highway revenues.

Urgency for Designating and Planning the System

It is highly important, therefore, that decisions in regard to the designation of the interregional system and standards for its development be reached and generally accepted as early as possible. If adequate plans and rights-of-way are to be ready in time to give prompt employment when the employment need is greatest (for the present war, there is indeed no time to spare in reaching the essential preparatory decisions.

The same urgency applies to the planning of city streets which would form a part of an interregional system, because as soon as it becomes possible to do so, the reconstruction needs of these streets will also be met in some manner. Most probably the manner adopted will be a simple reconstruction of existing pavements in most cases, unless a plan is agreed upon in advance for provision of the more ample facilities which all the facts adduced in this report show to be in the highest degree necessary.

The planning of these city facilities is no simple task. It is time-consuming. It requires the most careful study, the most difficult adjustments, the most complicated and expensive right-of-way acquisitions, the utmost of multilateral agreement between the various official bodies and interests concerned.

The essential prearrangements should be proceeding now. It will be lamentable indeed if, for want of understanding and pre-planning, it is found impossible to include in an early post-war program of public works, many of these badly needed improvements of city transportation systems.

PLANNING NOW IN PROGRESS

Under the act of 1941.—Preparations for post-war construction of the interregional system have fortunately not been entirely neglected. The Defense Highway Act of 1941[17] authorized an expenditure of $10,000,000 of Federal funds matching with State funds in the proportions required by the Federal Highway Act, for surveys and plans for the future construction of highways included in the strategic network of routes of principal military importance and on routes around and into and through municipalities and metropolitan areas.

With the required State matching, this Federal provision will probably make possible the completion of surveys and plans for construction projects totaling in cost nearly $500,000,000. The Public Roads Administration has widely urged upon the State highway departments the desirability of giving high priority in the selection of projects to be planned to those that will supply essential links in the system of interregional routes herein recommended.

The Federal funds authorized for this purpose have been apportioned among the several States as required by law, and, in part have been allocated with the approval of the Public Roads Administration to specific projects. The apportionment by States, the general programs of work approved, the status of allotment of the Federal funds to projects with the corresponding estimated total cost, the mileage of road involved in the planning projects, and the unprogrammed and unallotted balances of Federal funds, as of October 31, 1943, are shown in table 19.

TABLE 19.—*Apportionment and status of allotment of advance engineering funds, authorized by sec. 9 of the Defense Highway Act of 1941, as of Oct. 31, 1943*

State	Apportionment	Programs approved			Allotment to projects				Balances available for	
		Estimated total cost	Federal funds	Number of projects	Estimated total cost	Federal funds	Miles	Programming	Allotment to projects
Alabama	$308,278	$247,750	$123,875	6	$94,000	$47,000	106.6	$94,500	$181,375
Arizona	48,548	70,000	47,000					96,548	143,548
Arkansas	170,947	205,230	102,615	10	60,340	30,340	37.4	68,332	139,267
California	598,890	702,890	268,000	16	702,000	268,000	154.2		
Colorado	170,252	280,000	142,050	10	280,000	140,650	124.2	57,672	97,672
Connecticut	69,036	145,000	82,036	3	116,000	50,000	59.4		
Delaware	48,763	50,000	28,000					34,736	62,736
Florida	140,451							143,443	143,443
Georgia	284,720	82,430	46,210					205,510	251,720
Idaho	123,909	143,000	98,517	8	88,000	82,616	99.3	36,293	71,186
Illinois	394,778	1,000,918	300,705	10	302,568	196,278	166.4		195,500
Indiana	240,985							240,985	240,985
Iowa	249,425							249,425	249,425
Kansas	262,424	413,500	206,750	12	313,380	150,160	231.2	45,694	99,264
Kentucky	185,332	504,436	177,218	16	237,435	118,718	141.8	8,116	85,614
Louisiana	247,981	280,648	130,324	8	97,848	48,922	67.8	57,057	99,139
Maine	86,536	87,000	43,500	9	86,000	43,000	60.4	43,536	43,536
Maryland	93,062	93,062	93,062	4	87,462	87,462	47.0		
Massachusetts	295,874			6	96,032	34,016	60.3		
Michigan	302,904	606,788	302,894						302,904
Minnesota	270,733	413,000	206,500	16	226,000	113,480	85.8	63,733	157,253
Mississippi	176,010	33,000	16,500	5	16,500	8,250	16.6	161,260	169,760
Missouri	288,102	565,000	282,500	9	56,000	28,000	105.9	14,620	274,620
Montana	302,080	291,500	196,250	38	221,500	135,398	417.1	75,781	78,781
Nebraska	98,127	123,000	61,000	28	104,000	52,000	71.6	188,127	247,127

Subsequent detail project estimates will reduce program to amount of apportionment. $154,[illegible]

[17] Public Law 286, 77th Cong., sec. 9, approved Nov. 28, 1941.

TABLE 19.—*Apportionment and status of allotment of advance engineering funds, authorized by sec. 9 of the Defense Highway Act of 1941, as of Oct. 31, 1943*—Continued

State	Apportionment	Programs approved			Allotment to projects				Balances available for	
		Estimated total cost	Federal funds	Number of projects	Estimated total cost	Federal funds	Miles	Programming	Allotment to projects
Nevada	$127,391	$80,065	$40,044	8	$40,065	$20,044	34.2	$60,365	$80,395
New Hampshire	48,540	97,080	48,540	1	48,540	24,270	8.0		24,270
New Jersey		254,500	127,306	1	25,500	12,968	10.1		
New Mexico	162,[illegible]	75,000	37,500	3	38,000	24,000	41.1	60,165	97,887
New York	448,[illegible]	904,000	452,000	6	904,000	452,000	9.0		
North Carolina	278,[illegible]	62,000	31,000	6	78,000	39,000	16.4	200,456	239,956
North Dakota	90,000							149,000	89,000
Ohio	[illegible]	18,000	364,000	5	360,000	180,000	16.6		89,000
Oklahoma	237,[illegible]	60,000	30,000					31,000	61,000
Oregon	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
Pennsylvania	448,[illegible]	200,000	100,000	2	200,000	100,000	22.0	248,448	348,448
Rhode Island	48,[illegible]	96,000	48,000	1	96,000	48,000	11.0	240,000	288,000
South Carolina	48,[illegible]	9,000	4,500	6	9,000	4,500	8.8		4,500
South Dakota	90,000							45,000	45,000
Tennessee	64,[illegible]	96,000	48,000						
Texas	448,[illegible]	78,000	39,000					65,000	104,000
Utah	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
Vermont	48,[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
Virginia	48,[illegible]	96,000	48,000	2	22,000	11,000	2.5	69,000	117,000
Washington	48,[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
West Virginia	48,[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
Wisconsin	48,[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
Wyoming	48,[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
Puerto Rico	48,[illegible]	[illegible]	[illegible]					69,000	69,000
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] Subsequent detail project estimates will reduce program to amount of apportionment, $352,03[illegible]

Although the law properly does not restrict the application of these funds to the interregional system, the advice of the Public Roads Administration suggesting a preferential selection of projects conforming to the system has generally been heeded by the State highway departments with the result that a substantial majority of the projects now being surveyed and planned are of this character.

Sections of the recommended system for which planning provision had thus been made as of October, 31 1943, are shown on the map (fig. 36). Practically all of these projects are still in the surveying stage of planning. It is highly desirable that many of them as finally platted in detail shall conform in their design features either to the standards recommended in this report or to such other general standards as shall hereafter and shortly be adopted by common consent for general application to a system of interregional highways formally and officially agreed upon and designated.

Under the act of 1943.—By recent legislation[18] the Congress has made additional provision for survey and planning of post-war highway construction projects. This provision authorizes expenditure in each State for such planning purposes of an amount of the State's

[18] Public Law 146, 78th Cong., sec. 3, approved July 13, 1943.

noh gated balance of previously apportioned Federal-aid highway funds not to exceed its Federal-aid pro rata part of a hypothetical national total of $50,000,000 (see table 20), such amounts to be matched with State funds as required by the Federal Highway Act.

TABLE 20.—*Apportionment of a hypothetical $50,000,000 for post-war highway planning in accordance with the act approved June 28, 1943 (Public Law 148, 78th Cong., sec. 5)*

	Amount		Amount
Alabama	$1,073,478	New Jersey	652,905
Arizona	736,804	New Mexico	827,968
Arkansas	879,694	New York	2,470,659
California	2,453,073	North Carolina	1,236,314
Colorado	932,398	North Dakota	764,651
Connecticut	598,321	Ohio	1,801,450
Delaware	250,000	Oklahoma	1,158,268
Florida	746,686	Oregon	849,986
Georgia	1,287,[illegible]	Pennsylvania	2,995,420
Idaho	635,[illegible]79	Rhode Island	250,000
Illinois	2,[illegible]5,563	South Carolina	694,384
Indiana	[illegible],[illegible]7,432	South Dakota	804,920
Iowa	[illegible],[illegible]3,363	Tennessee	1,080,441
Kansas	1,361,[illegible]	Texas	3,247,700
Kentucky	[illegible]6,[illegible]44	Utah	576,968
Louisiana	7[illegible],893	Vermont	250,000
Maine	44[illegible],680	Virginia	93[illegible],[illegible]80
Maryland	[illegible]7,[illegible]4,[illegible]5	Washington	8[illegible],246
Massachusetts	[illegible],[illegible]40[illegible]	West Virginia	[illegible]93,062
Michigan	2,558,069	Wisconsin	1,244,127
Minnesota	1,379,894	Wyoming	638,001
Mississippi	920,859	Hawaii	250,000
Missouri	1,518,385	District of Columbia	250,000
Montana	1,036,240	Puerto Rico	253,036
Nebraska	1,021,014		
Nevada	654,046	Total	50,000,000
New Hampshire	250,000		

Not all of the funds thus authorized to be expended for post-war planning can be used for that purpose, for various reasons; and as yet the intentions of the States regarding such use of the funds authorized have not been determined to the extent necessary to permit an estimate of the amount that will probably be devoted to the authorized planning purpose. The Committee believes, however, that the State highway departments generally have a keen appreciation of the necessity to prepare thoroughly for a prompt resumption of highway construction after the war, and expects, therefore, that a substantial part of the additional Federal funds released for planning, with essential State-matching funds, will be used in most States for the intended purpose. In some States it is probable that the highway departments will prefer to reserve the unobligated Federal funds for construction and employ State funds only for advance planning purposes. But, in either case, it is believed that the recent additional provision will result in a large and prompt increase in the expenditure for post-war planning.

The Committee advocates that a principal part of such increased planning effort should be devoted to the planning of improvements conforming substantially to the standards herein proposed on the recommended interregional highway system.

FIGURE 26.—Map of the recommended interregional system, showing the location of advance engineering projects approved October 31, 1943

Costs of Improvements Proposed

It is impossible, on the basis of the very general studies made by the Committee, to venture even an approximate estimate of the total cost of building the entire interregional system to the standards recommended. To be of any value whatever, such an estimate would necessarily have to be predicated upon a far more exact determination of the location of the routes and of the manifold conditions of topography, soil, frequency of road intersections, property affected, etc., than it has been possible to undertake. Had it been possible to make such precise determinations, moreover, the usefulness and validity of an estimate of the ultimate cost of a construction program that must inevitably extend over a period of perhaps 20 years and be affected by unpredictable changes in the general economy in the habits and desires of the people, in the character of vehicles and in other circumstances would still be highly questionable.

Construction to the standards recommended will certainly be expensive beyond the common experience in building most of the ordinary existing roads and streets, but the merit of the expenditure is to be judged not by such a comparison but rather by the value of the advantages to be gained in traffic facilitation, in reduced costs of vehicle operation, and in lowered accident rates.

Costs in Rural Areas

A large part of the construction in rural areas, however, will not be highly expensive. As previously stated, the traffic in 1941 was less than 1,000 vehicles a day on existing roads conforming to approximately 21 percent of the total rural mileage of the system. The system as improved in these sections will attract a somewhat greater traffic, but the increase to be expected will not materially affect the design of the new facilities. Sections of the system of the general order of traffic volume can presently be built to the standards proposed at costs ranging between $40,000 and $60,000 per mile.

Rural sections of the system serving traffic averaging from 1,000 to 2,000 vehicles per day, a range characterizing 32 percent of the existing closely conforming roads in 1941, can probably be built to the proposed standards, at present prices, for $50,000 to $70,000 per mile.

These two traffic ranges, it will be noted, cover half of the entire mileage of rural roads approximating routes of the recommended system.

The existing roads that served traffic between 2,000 and 3,000 vehicles per day in 1941 made up 21 percent of the total; and the mileage of the system as built that would probably carry traffic of this order of density would doubtless be a somewhat larger percentage of the total. The cost of these sections would vary considerably according to the extent to which, on individual sections, it is necessary, in conformity with the standards proposed, to employ divided four-lane construction. Under the most favorable conditions, the cost of such sections would probably be little if at all greater than that of the sections serving traffic of between 1,000 and 2,000 vehicles per day. Where extensive four-lane construction is required, and on sections serving traffic approaching the upper limit of the range, the cost might closely approximate that of completely four-laned sections.

The latter design, required by the standards proposed for rural sections of the system serving traffic between 3,000 and 15,000 vehicles per day, might be required on more than 30 percent of the recommended system; and it would probably result in construction costs ranging between $100,000 and $700,000 per mile.

An impression of the character of rural improvements obtainable within these several cost ranges may be gained from the photographs of recently constructed sections of rural highways of high standard, presented in plates XI and XII.

Costs of Urban Sections

The costs of urban sections of the system may be expected to vary more widely than those of rural sections. Indication of costs in relation to traffic volume is impracticable, and the Committee attempts only to afford an impression of the range of possible costs by presenting photographs (pls. XIII and XIV) of actual facilities representative of various construction costs.

Rate of Expenditure and Employment on the System

The provision that has been made by the Federal Government for the planning of post-war highway improvements is unparalleled in any other field of public construction. The highway planning work in progress is directed to the completion of definite working plans capable of execution at the appropriate time. There is widespread interest in the development of plans for post-war public works of other kinds; but as yet the provision made for such other works does not compare in definiteness or adequacy with that which has been made for highway construction.

The Committee recognizes that highway construction generally, and improvement of the interregional system in particular, should be planned in appropriate balance with other needed public works. It therefore considers the early proposal and planning of such public works of all kinds to be highly desirable in order that there may be ample opportunity to integrate them into a well-proportioned composite program of essential works, to obtain the necessary statutory sanctions, and to ready the whole program for timely execution at the war's end.

The principle of providing for the advance planning and regulated construction of needed public works for the stabilization of industry and the alleviation of unemployment is well established. A complete readiness of desirable projects and a recognition of the propitious time for their launching are essential prerequisites to a fully effective injection of the stimulant of public works in a period when private activity is waning or in transition from war to peacetime production. While the unreadiness of public works projects in sufficient volume to cope with the severity of the recent depression delayed the stimulation of private activity, the eventual public works contribution to recovery fully established the soundness of the stabilization principle.

Precise prediction of the time and manner of the war's end is as difficult as an adequate description of the potentialities of forces currently at work, forces, the resultant of which will determine the fundamental conditions of the post-war era. These limitations, however, need not deter the provision of plans. Rather, the planning

will need to be alive to a wide range of possible conditions, and prepared to cope with any conditions that may eventuate, when they occur. For such an approach to post-war planning, the past quarter of a century has provided important signs and guideposts

CONSTRUCTION ACTIVITY AND NATIONAL INCOME

The Committee has analyzed the records of construction during this past period in an effort to discover the relations that have existed between total construction volume and the aggregate economy. It has attempted to identify the underlying conditions which have made for a varying relation in amount between public and private construction; to ascertain the magnitude of Federal in relation to total public construction expenditures, and particularly to examine the amount and character of Federal expenditures for highway construction in relation to the resulting benefits and employment.

Data available for these purposes, embracing the period from 1915 through 1942, are tabulated in appendix VII, table 1. These data have been considered in 4-year periods, selected to reflect the various relations of the several classes of construction, during two major periods, in prosperity and in depression, and in the rising and falling economy of the transitional periods between. The Committee believes that among these relations will be found analogies suggestive of a desirable pattern of expenditure for the post-war period

The broad relations of total construction volume and the aggregate economy are shown in table 21, which compares the total estimated cost of construction, including work relief and maintenance, with the national income in the typical periods.

TABLE 21.—*Comparison of total dollar volume of construction, public and private including maintenance and work relief with the national income, by periods from 1915 to 1942 inclusive*

Period	Total construction including work relief and maintenance[1]	National income payments to individuals	Ratio of construction to national income
	Millions of dollars	*Millions of dollars*	*Percent*
1915–18	60,448	348	23.1
1919–22	61,183	979	13.5
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
1939–42	64,107	92,502	11.7
1943–46	68,227	99,237	10.8

[1] Including work relief and maintenance.

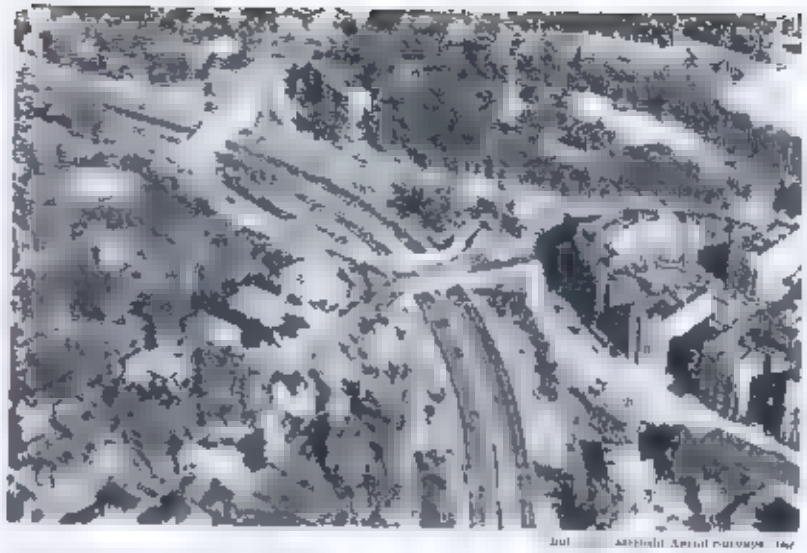
National income and construction activity associated.—Throughout all periods from 1915 to 1942, it is apparent from table 21 that fluctuations of the national income and the volume of construction activity, both measured in dollars, have been closely linked. Rising income has been accompanied by increasing construction activity. Declining construction activity has coincided with falling income. There is also an evident tendency, when income is rising, for construction activity to supply in increasing measure the source of the income

For sections of the system designed for traffic of less than 5,000 vehicles per day (like picture of an existing [illegible] highway), with wide shoulders and easy slopes, such sections can probably be constructed at costs ranging between 40 and 60 thousand dollars per mile, depending mainly upon the [illegible] of grading and the number of grade-separated intersections

[illegible] are the proposed [illegible] vehicles per day should [illegible] type. Cost may range between 80 and 70 thousand [illegible] and the number of grade-separated intersections

PLATE XI.—Existing highways conforming approximately to standards proposed for eight-traffic rural sections of the system

PLATE XII Existing highways conform ng approxima el standards proposed for heav ly traveled r an sections of th system



This ... New ... be ... highway n New York ... ...

... Ex ... ng ... ... forming approxi ately to standards ... ... ions of the system

and conversely, when income is falling, for construction to produce a smaller part of the reduced income

For these tendencies there are readily understandable causes. Construction activity makes its own demands for the production of a variety of materials, and both directly and indirectly increases employment, with consequent increase in the income of workers. Moreover, the normally substantial part of total construction activity that is made up of the private construction of industrial, commercial, social, recreational and public utility facilities is a barometer that indicates by its rise and fall the state of the economic weather, present and to come. Made up of uncoordinated aggregations of individual enterprise and highly responsive to change in the cost of funds used for its financing, private construction activity by its increase is indicative of an expanding economy, by its decrease, it indicates a recession of private enterprise, and by its own lessened demand for the production of materials and for workers, it hastens the economic decline which follows.

In the light of this discussion of the influence of private construction upon the national income, it is of interest to observe in table 22 the relations of the dollar volume of private and public construction, maintenance, and work relief to the national income in the several 4-year periods from 1915 to 1942.

In the three 4-year periods from 1915 to 1926, inclusive, the volume of private construction rose steadily from 8.6 percent of the national income in the first period to 14.2 percent in the third period. In these 12 years the national income increased nearly 128 percent from [illegible] billion dollars in 1915 to 73.6 billion dollars in 1926. For 3 of the next 4 years it increased slightly to a maximum of 79.6 billion dollars in 1929, and in 1930, the fourth year, dropped sharply to [illegible] billion dollars. This was the beginning of the depression.

For the 4 years 1927 to 1930, inclusive, the volume of all private construction [illegible] average of 14.2 percent for the preceding 4-year period. The reduced average for the 4-year period, in itself an index of impending depression, was the result of a decline in each of the years, markedly sharpened in 1930, as follows:

Year	Private construction and maintenance in percent of the national income
[illegible]	14.5
[illegible]	12.8
1929	13.6
1930	11.0

For 3 of the next 4 years, during which the period percentage reached a low value, the annual percentages continued to decline, at first sharply, then more slowly to a low point in 1933, which was only slightly exceeded in 1934, as follows:

Year	Private construction and maintenance in percent of the national income
1931	9.2
1932	6.7
1933	[illegible]
1934	[illegible]

[illegible] 44 [illegible]

Whether or not, as some economists believe, a too-rapid expansion of [illegible] or the year of it, was a principal cause of the depression, there is apparently some support in these figures for the thesis that the ensuing decline in private construction activity was an important contributing factor. Certainly, however, there is no evidence in the trend of public construction, as shown in table 22, to indicate that an excessive expenditure for public works was in any degree responsible; because such expenditures expressed as a percentage of [illegible] rose scarcely at all in the periods from 1915 to 1926, and not sufficiently to offset the decline in private construction as the depression approached in the next 4 years.

TABLE 22.—*Comparison of dollar volume of construction, including maintenance, by private, public, and Federal-work-relief classes, with the national income, by periods from 1915 to 1942, inclusive*

Period	National income (annual average)	Total private and public utility construction (annual average)	Ratio of total construction to national income	Total public construction, maintenance and Federal work relief: Public construction and maintenance, excluding Federal work relief (annual average)	Ratio of public construction and maintenance, excluding Federal work relief, to national income	Federal work relief expenditures (annual average)	Ratio of Federal work relief expenditures to national income	Total of public construction and maintenance, including work relief, and private and public utility construction (annual average)	Ratio of total construction, including work relief, to national income
	Million dollars	*Million dollars*	*Percent*	*Million dollars*	*Percent*	*Million dollars*	*Percent*	*Percent*	*Percent*
1915–18	[illegible]	2,731	8.6	[illegible]	3.6			8.5	[illegible]
1919–22	[illegible]	6,473	[illegible]	2,[illegible]	3.4			11.4	[illegible]
1923–26	[illegible]	9,837	12	2,550	3			12	[illegible]
1927–30	[illegible]	9,[illegible]	[illegible]	3,[illegible]	[illegible]			14.3	[illegible]
1931–34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.0	[illegible]
1935–38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13.4	[illegible]
1939–42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1915–42	[illegible]	[illegible]	9.8	[illegible]	4	[illegible]	6	[illegible]	[illegible]
1921–42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The figures of table 22 may suggest that an expenditure for all classes of construction and maintenance work approaching 18 percent of the national income is somewhat excessive. A ratio of 15 percent, approximating the 28-year average of the period 1915–42, inclusive, and the 4-year average of the period 1939–42 might represent a safe and perhaps sustainable relation.

But if the maintenance of some such relation is assumed to be desirable, to be accomplished by an increase of public construction as private construction decreases, it will be seen from table 22 that the combined measures of Federal, State, and local governments, taken prior to the outbreak of the war in Europe [illegible] apparently to attain that end.

The slight increase in the average ratio of the normal public construction expenditure to the national income, which measured the effort of the 4 years from 1931 to 1934, was sufficient only to raise the ratio for all construction to 11.8 percent of the national income, and [illegible] with the further addition of the early Federal work-relief expenditure, the percentage was raised only to 11.9, an average lower than the lowest previous 4-year average, recorded in the period from 1915 to 1918, inclusive.

In the 4 years from 1935 to 1938 the normal public construction expenditure, expressed as a percentage of national income, actually fell off sharply, and but for the increase in Federal work relief would have produced, with the still sluggish private construction program, a new low record for the total construction ratio. The Federal relief program, then at its height, doubtless played a significant part in the increase of national income, which falteringly began in this period.

But it was not until the last 4-year period, 1939–42, that the recovery trend of national income was firmly established, and significantly, in this period the ratio of total construction expenditure rose to its highest point since the onset of the depression. Averaging 14.8 percent of the national income for the 4-year period as shown in table 22, the total construction ratio did not fall below 14 percent in any year of the period, and in 1941 rose to a maximum of 16 percent coincidentally with a sharp increase in the national income from seventy-seven billion to nearly ninety-five billion dollars.

In the first 2 years of the period, reviving private construction combined with a stronger public construction program and large Federal work-relief expenditures [illegible] the construction ratio. In the last 2 years, with Federal relief expenditures declining, private construction yielded to the mounting public construction incident to preparation for the war; and after Pearl Harbor, public [illegible] relief [illegible] fell [illegible] 28-year average with an expenditure equal to 9.5 percent of a national income of nearly $120,000,000,000. With Federal work relief at the vanishing point, the country experienced in this first year of the war its nearest approach to full employment in more than a decade. Significantly, the year 1942 provided the sole example of public construction in sufficient volume to offset a reduced volume of private construction, and this was for purposes of destruction.

The course of these changes in the character of construction activity and in the national income and construction-income ratio is clearly shown in table 23.

TABLE 23.—*National income, private and public construction activity, and construction-income ratios by years, 1939–42*

Year	National income	Total construction and maintenance: Amount	Total construction and maintenance: Income ratio	Public construction and maintenance, excluding Federal work relief: Amount	Public construction and maintenance, excluding Federal work relief: Income ratio	Federal work relief: Amount	Federal work relief: Income ratio
	Million dollars	*Million dollars*	*Percent*	*Million dollars*	*Percent*	*Million dollars*	*Percent*
1939	[illegible]	[illegible]	14.4	[illegible]	9	1,228	5
1940	[illegible]	16,[illegible]	14.5	[illegible]	9	930	2
1941	94,[illegible]	[illegible]	14.9	[illegible]	9.2	918	6
1942	[illegible]	[illegible]	[illegible]	88	2.3	3,[illegible]	[illegible]

Precepts for stabilizing the economy.—From the foregoing discussion, three definite precepts emerge to form a basic consideration in the maintenance of a stabilized economy.

1. The principle of employing needed public works to stimulate a waning private economy is demonstrably sound

[illegible] preparation of integrated programs of public works required to [illegible] employed must be sufficient to offset the decline in the volume of private construction activity

3. It is important that the Federal Government reaffirm as a permanent policy the principle of cooperative provision of needed public works as a stimulus to a waning private economy, in order that private investment initiative may predicate its plans on the assurance of continuity in the public practice of this policy

Construction expenditure associated with economic health. In consideration of these fundamental precepts and the data previously examined [illegible] of construction and maintenance work, private and public, approximating 15 percent of the national income is a condition associated with the economic health of the country. The ratio should probably not be permitted to rise materially above 15 percent, and any substantial decline below that figure should be regarded as a danger signal and remedied by immediate increase of construction activity, by public stimulation when and to the extent necessary

In the light of this suggestion it is interesting to observe what occurred from the beginning of the depression onward. In the 4-year period 1927 to 1930, immediately preceding, the total construction [illegible] of the national income, of which 13.2 percent was for private construction and 4.3 percent for public construction with maintenance included in each figure

In the first 4 years of the depression, 1931 to 1934, the average annual expenditure for private construction and maintenance dropped sharply to an amount representing only 7.0 percent of the national income, a decline equal to 6.2 percent of the national income. To restore the total construction and maintenance ratio to 15 percent would have required an increase in the total public expenditure by an amount equal to 3.7 percent of the national income. In the 4-year [illegible] Federal Government was actually increased over the amount expended in the period 1927–30 by an amount equal to 1.1 percent of the national income. Of this increase, as shown by table 24, 0.3 percent was supplied by increase of Federal-aid highway expenditures and 0.2 percent by work-relief expenditures on highways. The remainder of 0.6 percent was made up of 0.4 percent for other Federal construction expenditures exclusive of work relief and 0.2 percent in work-relief expenditures. But, at the same time that the Federal Government was increasing its expenditures by the amount of 1.1 percent of the national income, expenditures for construction and maintenance by the States and their subdivisions were reduced by an amount equal to 0.5 percent of the national income, so that the net increase was only 0.6 percent of the national income, as compared with the 3.7 percent increase that was needed to compensate for the decline in private expenditure and restore the total construction and maintenance program to 15 percent of the national income. As a result, the total program dropped to 11.9 percent of the national income, and the national income dropped from an annual average of more than

$75,000,000,000 in the period 1927–30, to an annual average of less than $51,000,000,000 in the period 1931–34

In the next 4-year period, 1935–38, private construction and maintenance activity was increased, rising from an average of 7.0 percent of the national income for the previous period to 7.7 percent, as shown in table 22. To have provided a total construction and maintenance program amounting to 15 percent of the national income, a public expenditure equal to 7.3 percent of the national income would have been necessary. As the public expenditure of the preceding period (table 22) was 4.9 percent of the national income, this would have called for an increase equal to 2.4 percent of the national income

As shown by table 24, the Federal expenditure was actually increased over that of the preceding period by an amount representing 1.9 percent of the national income. No part of this increase was provided through the normal Federal-aid highway expenditures. Relief expenditures for highways were increased by an amount equal to 0.6 percent of the national income, and the balance of the increase, amounting to 1.3 percent, was provided, 0.7 percent in normal construction operations other than highway work and 0.6 percent in relief expenditures for other than highway work.

But while the Federal Government was thus increasing its construction expenditures by 1.9 percent of the national income other governmental expenditures for construction and maintenance declined by an amount equal to 1.4 percent of the national income, so that the net increase in public expenditures was only 0.5 percent which with the 0.7 percent increase in private construction increased the total construction and maintenance program to only 13.1 percent of the national income from the lowest average of 11.9 percent registered in the preceding period. Nevertheless the national income increased from an annual average of less than 51 billion in the preceding period to more than $63,000,000,000 in the period 1935–38. Recovery was marked, but by no means assured, and unemployment was still large

It remained for the threat of war to provide the stimulus necessary to raise the construction ratio to the 15-percent level suggested as desirable. The 14.8 percent ratio recorded for the 4 years from 1939 to 1942 was largely the result of expanded Federal construction operations incident to preparation for the war and its conduct in the first year. Private construction in this 4-year period dropped from [illegible] construction, including maintenance and relief work, dropped from 2.9 to 2.3 percent of the national income (table 24). Relief expenditures for other than highway work dropped from 0.8 to 0.4 percent and non-Federal expenditures for other construction work increased only from 0.2 to 0.4 percent of the national income. The large increase occurred in Federal expenditures other than for highways, an increase from 1.3 to 4.5 percent of the national income. This increase was sufficient to offset the other declines and restore the total construction ratio to an average of 14.8 percent for the 4 year period. It was devoted largely to the construction of Army camps and other military and naval establishments and to plants for the manufacture [illegible] men and provide means for destruction. But nevertheless the effect

TABLE 24.—Class fluctuations of public construction, maintenance, and relief expenditures, by highways and other classes of work, by Federal and non-Federal expenditures, and by periods from 1915 to 1942, inclusive

1 Represents Federal expenditures only on cooperative work. 2 Substantially all highway maintenance expenditures are by State and local governments.
3 Includes Federal maintenance expenditures. 4 0.001 percent.

of the enlarged expenditure for construction and of other expenditures for arms and ammunition, was practically to erase unemployment and raise the national income to an unprecedented high level

HIGHWAYS AND CONSTRUCTION ACTIVITY

Federal versus local government expenditures for highways In respect to highway construction and maintenance, table 24 shows that the average total expenditure by all agencies of government increased steadily from one of the 4-year periods to another prior to 1931, both in the absolute amount of the expenditure and in percentage of the national income, reaching a maximum predepression level of nearly 1 9 billion dollars and 2 5 percent of the national income. Through all these periods the Federal highway expenditure averaged only about 0 1 percent of the national income

With the onset of the depression in the period 1931–34, the Federal Government increased its regular highway-construction expenditure to an average for the period equal to 0 4 percent of the national income and to this added highway work relief expenditures averaging for the period 0 3 percent of the national income. The total Federal increase, equal to 0 5 percent of the national income was partially offset by a decrease in the expenditure of local governments so that the net increase, expressed as a percentage of the national income, was only 0 4 percent and this was insufficient to prevent a decline in absolute expenditure which reduced the total to less than 1.5 billion dollars

In the following period, regular Federal expenditures remaining at 0.4 percent of the national income work-relief expenditures on highways increased to an annual average of 0.8 percent of the national income a Federal increase representing 0 6 percent of the national income which was completely offset by an identical decrease in the [illegible] of highway expenditures by local governments so that the total ratio remained at 2 9 percent of the national income the same as in the preceding period. In absolute amount, however, the total expenditure increased, with the national income, from less than 1 5 to a little more than 1 5 billion dollars, an amount slightly less than the average expenditure of the last predepression period

In the last period, 1939–42, regular Federal expenditures for highway construction were reduced to an amount representing 0.2 percent of the national income and work relief highway expenditures to 0 5 percent of the national income, a total Federal reduction equal to 0 8 percent of the national income which, with a further reduction in local government expenditures, dropped the total highway expenditure for the period to an average of 2.2 percent of the national income equivalent to an absolute expenditure above 1 9 billion dollars.

Reduction in local expenditures offset Federal increases —Throughout all of the first two 4-year periods from 1931 and for at least half of the final period there was need to increase public construction and maintenance expenditures to offset the decline in private expenditures and provide employment for idle workers and idle industry But the substantial efforts of the Federal Government to accomplish this result, in part by the stimulation of highway [illegible] were ineffective because of reductions in local highway expenditures.

Nor could these reductions in local expenditure be justified on grounds of reduced need of expenditure. Throughout all three 4-year

periods there was widespread recognition of the need for increased effort in highway construction and maintenance.

The total number of vehicles in operation dropped slightly from the previous peak in 1937 to 1938, but increased annually from the new low point to a new peak in 1941, a total increase of 15 percent. The consumption of motor fuel declined slightly in 1938 from the previous year's peak, but increased annually thereafter to a new peak in 1941. Motor-fuel consumption in 1938 was 14½ billion gallons, or 1 billion gallons less than in 1937. Consumption increased to nearly 24 billion gallons in 1941, an increase of 66 percent in the 8 years. In each year from 1932 through 1941, the gallons of motor fuel consumed per vehicle registered and per capita of population was greater than in any previous year.

TABLE 25.—*Motor vehicles in operation and motor fuel consumption, total annual average and annual average per vehicle, by 6-year periods, 1931–42*

	Motor vehicles in operation, annual average	Motor-fuel consumption, annual average	Motor-fuel consumption per vehicle, annual average
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

The rapidly increasing volume of motor-vehicle traffic indicated by these figures was the worst of highway surfaces. Higher speeds of travel had made many of the older alinements dangerous. The old [illegible] A large mileage of the roads first built was each year reaching the point of desirable reconstruction [illegible] In addition, or at least the latter half of the three-period span, there was clear recognition of the need for radical and expensive improvements of the principal approaches [illegible] of [illegible]

In spite of these recognized needs for highway improvement and [illegible] rates for highways, both for construction and maintenance, were [illegible] by [illegible] increases in Federal expenditure, so that the employment purposes of the Federal Government were largely or completely nullified.

Committee recommendation—Return to tested principles.—To forestall a similar defeat of any post-war effort of the Federal Government to provide, through highway construction, for increased employment, the Committee recommends a return to the tested principles of the Federal Highway Act which require (1) the Federal contribution to construction to be matched in substantially equal amount by the States [illegible] with Federal assistance. Whatever may be the cooperating governments, whether States, [illegible] of these [illegible]

Construction expenditures to maintain national income. For the [illegible]

an average annual expenditure of at least $750,000,000 will be required for several years after the war, an amount that may have to be exceeded in the first years to catch up as quickly as possible with needs deferred because of the greater necessities of the war. The conservatism of this estimate is indicated by the fact that highway and street maintenance expenditures, clearly so recognized in the 4 years, 1939–42, averaged $640,000,000 per year, as shown on table 24, and these expenditures were doubtless augmented by part of the work-relief [illegible] was made for essentially maintenance purposes. The post-war maintenance expenditure, whatever may be its reasonable amount, must be made as early as possible in order to halt the road and street deterioration which wartime neglect has permitted, and it should have first call upon the post-war current highway revenues of the States and their subdivisions.

The additional amount it will then be possible and desirable to expend for highway construction will depend upon the magnitude of the national income and the requirements of private construction and maintenance and other kinds of public construction.

It has often been suggested that the national income should not be allowed to fall below $100,000,000,000. On the assumption that this is a desirable minimum, the Committee considers the expenditure of approximately 15 percent of that sum, or $15,000,000,000, as reasonable [illegible] public and private.

The maximum past expenditure for private construction and maintenance was the average of just under $10,000,000,000 recorded in the 4 years 1927–30 (table 22). In the 4-year period leading up to the war the private expenditure averaged approximately 6.5 billion dollars per year. With due allowance for a substantial expenditure for housing and expecting that the conversion of war plants will reduce the construction essential for resumption of peacetime industry, the Committee estimates that the post-war requirement of private construction will not exceed an average of $8,000,000,000 per year or 8 percent of a national income averaging $100,000,000,000. This will leave a balance of $7,000,000,000 of the desirable $15,000,000,000 total for all kinds of construction to be employed for public construction and maintenance of all classes.

Referring again to table 24, it will be observed that in each of the 4-year periods for which public construction expenditures are summarized, excepting only the period 1915–18 when highway improvement had been scarcely begun and the period 1939–42 when war [illegible] highway construction was [illegible] in excess of the expenditure for all other classes of public construction and maintenance. A similar division will be observed in the work-relief expenditures of the three 4-year periods from 1931 to 1942, inclusive.

An equal division of the $7,000,000,000 estimated above as likely to be available for all classes of public construction immediately after the war, would allot to post-war highway construction and maintenance 3.5 billion dollars. As will be seen from table 24, this amount substantially exceeds the largest previous sustained highway expenditure. Nevertheless, the Committee considers that all necessary preparation

above I e made for a post-war highway expend t re at that rate The extraordinary improvement of the interregional highways system proposed in this report may be counted upon to absorb any excess that may exist above the normal requirements of highway redevelopment and maintenance

Should private construction or the requirements of other classes of public construction exceed the estimates on which the expenditure for highways may be based In any case however the general character of highway and street improvement during the years immediately following the war would not be less than $3 000 000

Local expenditures on the interregional system During the $750 000 000 for maintenance from all sources of highway and street expenditures of $6 000 000 000 dollars for construction The Committee's estimates indicate that the interregional highway system will require approximately one half of the total highway funds of the country If the proportion of the total expenditures which will be required for the interregional highway system is applied to the proportion of the total expenditures which will be required for the improvement of urban streets the annual expenditure for urban streets would be $450,000,000

Based on past experience these expenditures would give employment to approximately 450 000 persons in addition to those employed in the manufacture of materials and in the transportation of men and materials to the construction projects

Of these expenditures for the system The Committee estimates that urban sections of the system, improved as recommended, will earn on the average, practically double their cost

These expenditures for the system for the first 10 years after the war should be supplemented by an additional expenditure for the improvement of the last 50 per cent of the system to provide a total of at least 60 per cent of the system improved to four lanes or its equivalent With all cost expenditures at the rate of 2 billion dollars annually there would remain expenditures for improvement of the system to the amount of at least $1 billion and preferably $750 000 000

With due regard for the relative needs of improvement within and without the system the Committee suggests that expenditures in the immediate post war years at the rate of $400 000 000 per year on urban sections of the interregional system and $250 000 000 per year on rural sections is necessary to return the system to a condition of service which can be achieved within a total construction expenditure of 2.2 billion dollars annually without jeopardy to the essential improvement of other parts of the entire road and street system

EMPLOYMENT POSSIBILITIES IN HIGHWAY CONSTRUCTION

Relation of construction expenditure and employment.—As bases for an estimate of the employment that may be afforded by all highway construction and maintenance and particularly by construction of the interregional system after the war, appendix VII gives in table 2 the actual man-months of direct employment on Federal, Federal-aid, and independent State highway construction and on highway maintenance by the States, by months from 1931 to 1942, inclusive, and in table 3, the same employment by yearly and 4-year periods. For comparison with these employment figures, table 4 in appendix VII shows for the same years and periods the annual expenditures of Federal and State (exclusive of local) funds for highways constructed and maintenance work on which the employment recorded in tables 2 and 3 was afforded

From the data included in these basic tables, expenditures per man-year of direct employment on construction and maintenance work and in both classes of work combined for periods over which actually existed, have been computed, and are given in table 26

TABLE 26.—*Expenditures per man-year of direct employment on Federal and State highway construction and State highway maintenance, years and 4-year periods 1931 to 1942, inclusive*

Year	Expenditures per man-year of direct employment			Expenditures per man-year of direct employment		
	Construction	Maintenance	Construction and maintenance combined	Construction	Maintenance	Construction and maintenance combined
	Federal and Federal-aid highways	State highways	Federal and Federal-aid highways and State highways	Federal and Federal-aid highways	State highways	Federal and Federal-aid highways and State highways
1931	$3 [illegible]	$1 [illegible]	$2 [illegible]	[illegible]	$1 040	$2 [illegible]
1932	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1933	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1934	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1935	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1936	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1937	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1938	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1939	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1940	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1941	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1942	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PERIOD AVERAGES						
[illegible]	[illegible]	[illegible]	$2, 260	282 42	4 [illegible]	679	3, 226
[illegible]	[illegible]	[illegible]	2, 510	[illegible]	3 [illegible]	545	2, 905

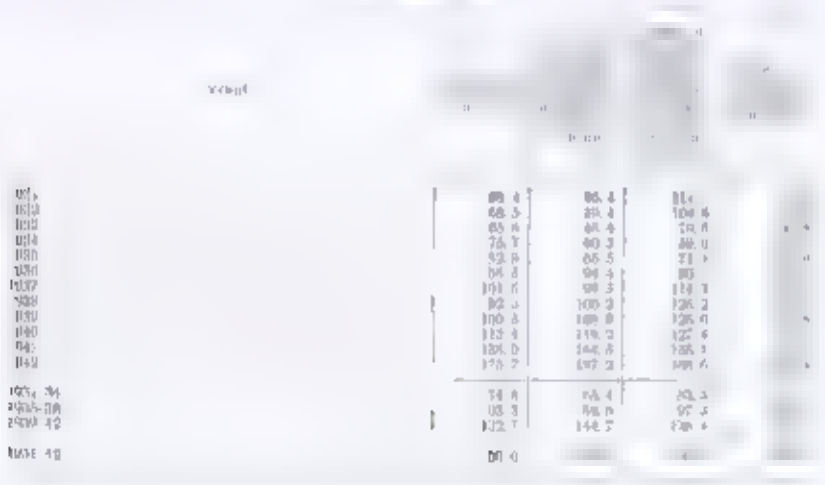
[1] Includes maintenance of Federal-aid highways.
[2] Preliminary estimate

It will be noted that in 1934 the expenditure to provide a man-year of direct employment on Federal and State highway construction was as above $2 000 whereas in the latest complete war year this figure had been almost trebled. The variation in the expenditure for direct highway employment is affected both by administrative policy and the state of the national economy. The low point of depression produced the lowest expenditure per man-year of direct employment, partly as a result of a general deflation of wages and prices. But policy limitations of hours of work designed to spread employment and wage ceilings fixed for various classes of work, also operated to

reduce average direct labor earnings and, therefore, the total expenditure for employment. At the same time, the use of machinery and equipment was abandoned with the purpose of increasing the relative volume of direct employment, and this was accomplished only at the expense of increased total costs, a reduced total volume of work accomplished, and a reduced employment of indirect industrial labor. In subsequent years, when wage and hour restrictions were relaxed to closer accord with the national economic trend, there were resulting increases in the cost of direct employment. In these later years however, there was a resumption of efficient methods of construction, so that despite the higher labor cost, total construction costs were reduced. Moreover the resulting stimulus both to direct employment and to the equipment, material and supply functions of industry, amply demonstrated the wisdom of the later policy.

The variation in the expenditure per man-year of direct highway employment through the period from 1931 to 1943, inclusive, in relation to the total economy as expressed by the national income and to the total dollar volume of all classes of construction, and the resulting effects of the wage variation and policy decisions referred to, on over-all highway construction prices are shown by the comparative indexes of table 27.

TABLE 27.—*Indexes of national income, total construction dollar volume, highway construction expenditure per man-year of direct employment, and highway construction cost*



From the regularity of the relation between the cost of providing direct highway employment and both the total dollar volume of all construction and the national income throughout most of the period, it appears that natural economic forces may be depended upon to induce essential variations in both wages and hours of work without the necessity of invoking extraordinary artificial controls over either wage rates or working hour maxima. The lack of agreement between the trend of highway construction prices and the trend of total construction volume in the middle thirties indicates the inadvisability

of sacrifice of efficient methods in favor of hand-labor and spread-work procedures. [illegible] maximum physical production of needed facilities by the most efficient mechanical methods, applied at reasonable wage and hour levels, and to obtain thereby the fullest stimulus to the recovery of private industrial processes and resulting indirect employment.

Effect of price inflation.—Another important indication of these data is the measure they afford of the probable effect of the construction volume-price relationship on the feasibility of post-war construction. It will be noted that no construction volume in the entire series, other than the extreme volume induced by war activity in 1942 operated to elevate the price of highway construction above the levels obtaining in the middle thirties, which were largely generated by a maximum of mechanical efficiency. This record gives considerable assurance that a large program of public construction can be undertaken after the war at any level below that of a wartime economy without serious reduction of the employment value of the expenditure by price inflation.

Direct and indirect employment.—The total employment value of any public highway construction program consists in the primary employment created at the job sites and the secondary industrial employment resulting from the use of equipment, materials, supplies and transportation services. Both in the direct and indirect groups wage and hour conditions tend toward a natural variation with general economic conditions. These natural variations affect the relative volumes of direct and indirect employment as well as the total employment [illegible] the total volume of construction [illegible] employment provided by a construction expenditure [illegible] and wages.

TABLE 28.—*Wages and hours of work and volume of highway employment provided by [illegible] in each of a selected series of years*

Item	[illegible]	[illegible]	[illegible]
Period, years			
Average hourly wage			
[illegible]	85 48	90, 68	80. 10
Direct and indirect employment	[illegible]	[illegible]	[illegible]
Ratio, direct to indirect employment	[illegible]	[illegible]	[illegible]
Man-hours employment			
Direct employment	30, 070, 000	35, 640, 000	32, 010, 000
Indirect employment	120, 280, 000	94, 320, 000	78, 030, 000
Direct and indirect employment	150, 350, 000	127, 960, 000	110, 040, 000
Ratio, direct to indirect employment	1 : 3 92	1 : 2 80	1 : 2 44
Average hours per month			
Direct employment	42	46	40
Indirect employment	168	132	120
Direct and indirect employment	143	77	100
[illegible]	1 : 4 67	1 : 2 30	1 : 3 00
Average monthly wage			
Direct employment	$44	$68	$120
Indirect employment	207	110	110
Direct and indirect employment	191	84 33	107
Ratio, direct to indirect employment	1 : 4 82	1 : 1 60	1 : 1 07
Number employed			
Direct employment	455, 300	332, 200	203, 400
Indirect employment	778, 800	517, 400	304, 000
Direct and indirect employment	1, 332, 300	849, 600	507, 400
Ratio, direct to indirect employment	1 : 1 71	1 : 2 55	1 : 1 99

TABLE 28.—*Wages and hours of work and volume of highway employment provided by a Federal and State expenditure of $100,000,000 for construction in each of 3 selected periods*—Continued

Period, years	1931-33	1940-41	1942-43
Man-years employed:			
Direct employment [illegible]	[illegible]	[illegible]	[illegible]
Indirect employment [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Ratio, direct to indirect employment	1 to [illegible]	1 to 2.33	1 to [illegible]
Average yearly wage:			
Direct employment	$840	$1,190	[illegible]
Indirect employment	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Ratio, direct to indirect employment	1 to [illegible]	1 to 1.40	1 to [illegible]
Expenditure for construction (salaries and wages):			
Direct employment	$24,591,000	[illegible]	[illegible]
Indirect employment	$74,[illegible]	[illegible]	[illegible]
Direct and indirect employment	$100,000,000	$100,000,000	$100,000,000
Ratio, direct to indirect employment	1 to [illegible]	1 to 3.54	1 to [illegible]
Expenditure per man-year of direct employment	[illegible]	[illegible]	[illegible]

The first period, 1931-33, measures the results actually obtaining [illegible] the framework of [illegible] second period, 1940-41, represents the conditions obtaining during the approach to war economy. In this period wage and hour conditions were at natural economic levels [illegible] and the price trend is the logical result of the total volume of activity. The third period, 1942-43 [illegible] has greatly stimulated price levels, wages, and hours of work.

If it may be assumed that the post-war return from the wartime peak to more normal conditions of peace will reverse the trends of the period of [illegible] those that will obtain in the post-war years. In that event, as indicated by table 28, it may be [illegible] will [illegible] man-years of direct and [illegible] man-years of indirect employment for each $100,000,000 expended annually.

Under the same conditions highway maintenance, as shown in table 29, may be expected to provide approximately 54,600 man-years of direct and 26,550 man-years of indirect employment for each $100,000,000 expended annually.

TABLE 29.—*Wages and hours of work and volume of highway employment provided by an expenditure of $100,000,000 for maintenance under assumed post-war conditions*

	Direct employment	Indirect employment	Total employment	Ratio, direct to indirect employment
Average hourly wage	[illegible]	[illegible]	[illegible]	[illegible]
Man-hours employed	[illegible]	[illegible]	[illegible]	[illegible]
Average hours per month	[illegible]	52	[illegible]	[illegible]
Average [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Man-months employed	[illegible]	[illegible]	[illegible]	[illegible]
Man-years employed	[illegible]	[illegible]	[illegible]	[illegible]
Average yearly wage	[illegible]	[illegible]	[illegible]	[illegible]
Expenditure for [illegible] (salaries and wages)	$52,[illegible]	$47,[illegible]	$100,000,000	[illegible]
Expenditure per man-year of direct employment	[illegible]			

On the basis of these estimates, the total highway program of [illegible] and [illegible] indirect employment.

Of these totals, the interregional system constructed at the recom[illegible] would employ each year approximately 145,100 man-years directly and [illegible] man-years indirectly, or a total of 458,500 man-years per year.

DISTRIBUTION OF EMPLOYMENT ON THE INTERREGIONAL SYSTEM

[illegible] of greatest employment need on the system.—As previously [illegible] more or less extensive sections of the recom[illegible] from the activities of war to those of peace.

[illegible] and at the points in each State where there will be the greatest employment needs.

[17] See footnote [illegible]

Character of direct employment.—The character of this direct employment, if it conforms to the typical highway pattern, will comprise various classes of workers as follows:

	Per cent
Administrative, executive, and supervisory personnel	13.6
Labor	
Skilled	15.4
Intermediate	25.2
Unskilled	45.8
Total direct employment	100.0

Character of indirect employment.—Indirect employment will be provided in the production, processing, and distribution of 11 general classes of equipment and 9 basic items of material, in addition to supplies for the operation and maintenance of equipment and innumerable minor items. The materials of highway construction are of widespread occurrence in nature. They emerge from farms, forests, mines, and quarries. The major quantities of materials actually incorporated in the finished highways are those of most common origin [illegible] are common to every State. In addition to the frequent local production of aggregates by highway contractors there are nearly 2,500 regular commercial producers scattered throughout the country.

Portland cement is produced in 169 mills, principally in 12 scattered States [illegible] by far the largest producers in the United States, and from 1935 to 1939 no State was unaffected by the [illegible] engaged in the manufacture of concrete products variously incorporated into finished highways.

Petroleum products derive principally and mutually from the 18 oil-producing States in 7 scattered regions. Highway use of petroleum and other bituminous products is extremely general, and consists of [illegible] bituminous materials incorporated in the roads as binders. Thus, the employment benefits resulting from the production and distribution of petroleum products for highway use are far reaching.

Similarly, in the production for highway use of large elements of iron and steel which are involved both in the manufacture of equipment and in the fabrication of highways, the employment values and the stimuli to industry are both general and widespread. The use of lumber, lumber products, and kiln products such as brick and tile are other examples of materials, the manufacture and transportation of which yield widely distributed benefits.

The [illegible] likewise a major item in the provision of employment. The ownership expense, exclusively for highway construction equipment, is calculated to exceed $140,000,000 annually. Repair and replacement requirements are about the equal of depreciation in the long run, and the unprecedented use of construction equipment during the war emergency is indicative of the need for extensive replacement and maintenance when the green light comes on again. In all probability [illegible] the States.

[illegible] California, Illinois, Iowa, Kansas, Michigan, Missouri, New York, Ohio, Pennsylvania, [illegible] and Texas.

CONCLUSIONS AND RECOMMENDATIONS

All of these facts indicate that the indirect employment that could be afforded by construction of the proposed system would be widely [illegible] this indirect employment would be very quickly generated.

In addition to the benefits to be afforded by the provision of much needed modern highway facilities, the Committee concludes that construction of the recommended interregional system will make possible the productive utilization of a substantial part of the manpower and industrial capacity likely to be available in the post-war period. It also desires to give special emphasis to the importance of complete readiness for an immediate post-war initiation of construction as a condition precedent to the ultimate success of any comprehensive public works plan which looks toward the stabilization of the national income and the preservation of prosperity in the post-war period. [illegible] regional-highway-system construction as an integral part of that plan in the advance planning and design of component high-priority projects, and in the acquisition of required rights-of-way, serve to emphasize the need for their prompt and thorough consideration.

The Committee, therefore, strongly recommends the early provision of all required legal authorizations and statutory sanctions, to permit all necessary administrative preparatory measures to follow in swift succession, and to insure a prompt beginning of construction on the system at the end of the war and prosecution of such construction at the rate indicated by an annual expenditure of $750,000,000.

APPENDIX I

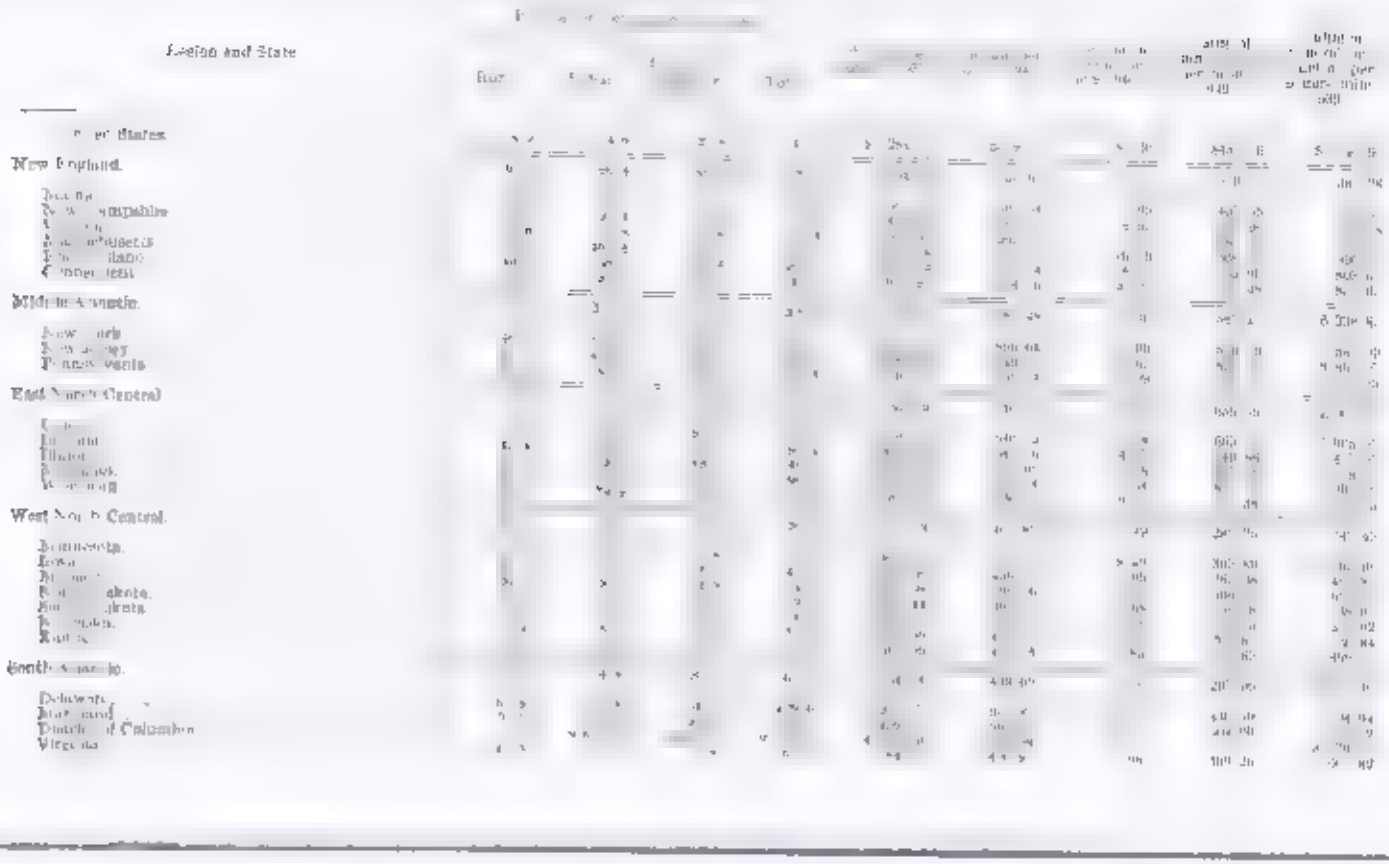
Population and Economic Statistics by Regions and States

Table 1.—*Selected population and economic data by regions and States*

Region and State	Rural	Total	Area (sq. mi.)	Population per sq. mi.	Gainful workers	Value added by manufacture	Value of crops, 1939
United States							
New England							
Maine							
New Hampshire							
Vermont							
Massachusetts							
Rhode Island							
Connecticut							
Middle Atlantic							
New York							
New Jersey							
Pennsylvania							
East North Central							
Ohio							
Indiana							
Illinois							
Michigan							
Wisconsin							
West North Central							
Minnesota							
Iowa							
Missouri							
North Dakota							
South Dakota							
Nebraska							
Kansas							
South Atlantic							
Delaware							
Maryland							
District of Columbia							
Virginia							
West Virginia							
North Carolina							
South Carolina							
Georgia							
Florida							
East South Central							
Kentucky							
Tennessee							
Alabama							
Mississippi							
West South Central							
Arkansas							
Louisiana							
Oklahoma							
Texas							
Mountain							
Montana							
Idaho							
Wyoming							
Colorado							
New Mexico							
Arizona							
Utah							
Nevada							
Pacific							
Washington							
Oregon							
California							

[1] Preliminary figures.
[2] Department of Commerce, Bureau of the Census.
[3] U. S. Department of Agriculture.
[4] U. S. Bureau of Mines.

TABLE 2. *Selected population and economic indexes by regions and States*



APPENDIX II

LOCATION OF OTHER HIGHWAY SYSTEMS AND AREAS AND VILLAGES INVESTIGATED BY THE COMMITTEE

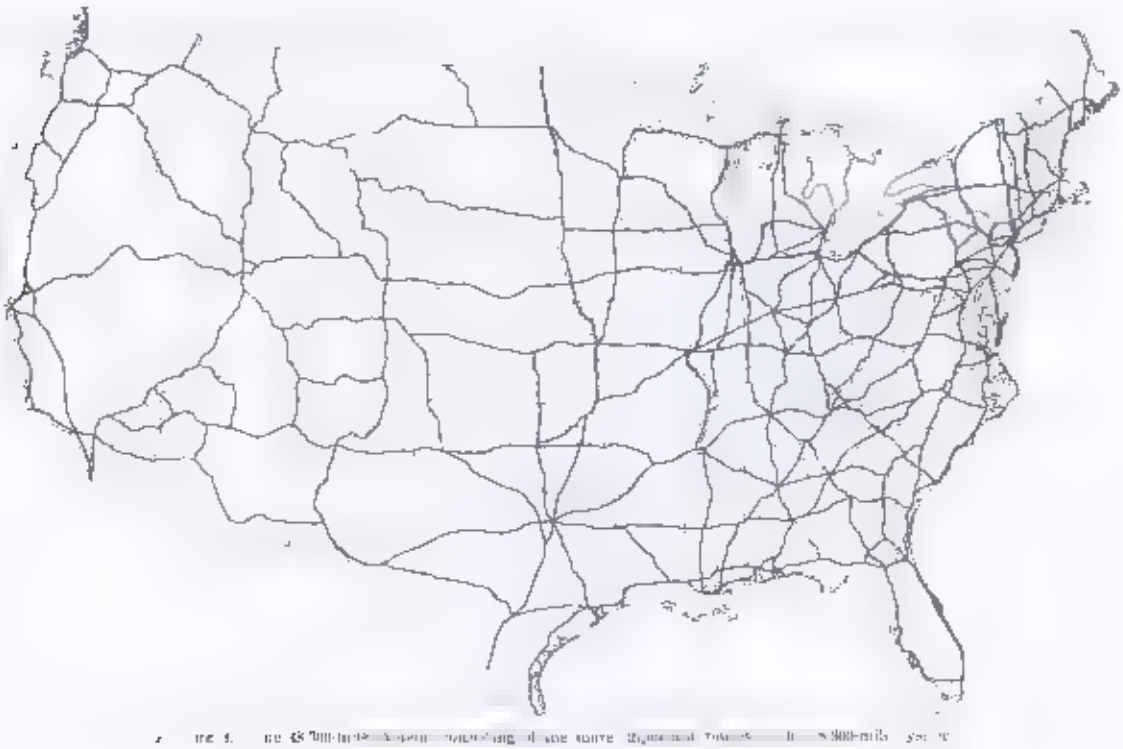


FIGURE 8.—The 26,000-mile system. This is the largest system investigated by the Commission.

APPENDIX III

Model Limited Access Highway Law

Recommended by the Public Roads Administration, Federal Works Agency

AN ACT To provide for the planning, designation, establishment, use, regulation, alteration, improvement, maintenance, and vacation of limited access facilities, the acquisition of lands required therefor, the restriction of intersections and control of approaches, the establishment of local service roads, the prohibition of certain acts thereon and provision for penalties therefor, and for other purposes.

SECTION 1. DECLARATION OF POLICY.—The legislature hereby finds, determines, and declares that this Act is necessary for the immediate preservation of the public peace, health, and safety, and for the promotion of the general welfare.

SEC. 2. DEFINITION OF A LIMITED ACCESS FACILITY.—For the purposes of this Act, a limited access facility is defined as a highway or street especially designed for through traffic, and over, from, or to which owners or occupants of abutting land or other persons have no right or easement or only a limited right or easement of access, light, air, or view by reason of the fact that their property abuts upon such limited access facility or for any other reason. Such highways or streets may be parkways, from which trucks, busses, and other commercial vehicles shall be excluded, or they may be free ways open to use by all customary forms of street and highway traffic.

SEC. 3. AUTHORITY TO ESTABLISH LIMITED ACCESS FACILITIES.—The highway authorities of the State, counties, cities, towns, and villages, acting alone or in cooperation with each other or with any Federal, State, or local agency of any state that may have a property or participate in the construction and maintenance of highways, are hereby authorized to plan, designate, establish, regulate, vacate, alter, improve, maintain, and provide limited access facilities for public use wherever such authority or authorities are of the opinion that traffic conditions, present or future, will justify such special facilities: *Provided*, That within cities and villages such authority shall be subject to such municipal consent as may be provided by law. Said highway authorities of the State, counties, cities, villages, and towns in addition to the specific powers granted by this act shall also have and may exercise relative to limited access facilities any and all additional authority now or hereafter vested in them relative to highways or streets within their respective jurisdictions. Said units may regulate, restrict, or prohibit the use of such limited access facilities by the various classes of vehicles or traffic in a manner consistent with section 2 of this Act.

SEC. 4. DESIGN OF LIMITED ACCESS FACILITY.—The highway authorities of the State, county, city, town, and village are authorized to so design any limited access facility and to so regulate, restrict, or prohibit access as to best serve the traffic for which such facility is intended; and its determination of such design shall be final. In this

connection such highway authorities are authorized to divide and separate any limited access facility into separate roadways by the construction of raised curbings, central dividing sections, or other physical [illegible] by [illegible] signs, markers, stripes, and the proper lane for such traffic by appropriate [illegible] have any right of ingress or egress to, from, or across limited access facilities to or from abutting lands, except at such designated points at which access may be permitted, upon such terms and conditions as may be specified from time to time.

SEC. 5. ACQUISITION OF PROPERTY AND PROPERTY RIGHTS.—For the purposes of this act, the highway authority of the State, county, city, town or village may acquire private or public property and property rights for limited access facilities and [illegible] rights of access, air, view, and light, by gift, devise, purchase or condemnation in the same manner as such units are now or hereafter may be authorized by law to acquire such property or property rights in connection with highways and streets within their respective jurisdictions. [illegible] shall be in fee simple.[1] In connection with the acquisition of property [illegible] or service road in connection therewith the State, county, city, town or village highway authority may, in its discretion, acquire an entire lot, block, or tract of land, if by so doing, the interests of the public will be best served, even though said entire lot, block, or tract is not immediately needed for the right-of-way proper.

SEC. 6. PREFERENCE OF CONDEMNATION CASES.—Court proceedings necessary to acquire property or property rights for purposes of this Act shall take precedence over all other causes not involving the public interest in all courts, to the end that the provision of limited access facilities may be expedited.

SEC. 7. NEW AND EXISTING FACILITIES, GRADE CROSSING ELIMINATIONS.—The highway authority of the State, county, city, town, or village may designate and establish limited access highways as new and additional facilities or may designate and establish an existing street or highway as included within a limited access facility. The State or any of its subdivisions shall have authority to provide for the elimination of intersections at grade of limited access facilities with existing State and county roads and city and town or village streets, by grade separation or service road, or by closing off such roads and streets at the right-of-way boundary line of such limited access facility [illegible] highway or street which is not part of said facility shall intersect the same at grade. No city, town or village street, county or State highway or other public way shall be opened into or connected with any such limited access facility without the consent and previous approval of the highway authority of the State, county, city, town, or village having jurisdiction over such limited access facility. Such consent and approval shall be given only if the public interest shall be served thereby.

[1] It sometimes difficult to obtain a fee-simple title where railroad interests are involved. In such instances, an appropriate easement in perpetuity may be satisfactory.

SEC. 8. AUTHORITY OF LOCAL UNITS TO CONSENT.—The highway authorities of the State, city, county, town, or village are authorized to enter into agreements with each other, or with the Federal Government, respecting the financing, planning, establishment, improvement, maintenance, use, regulation, or vacation of limited access facilities or other public ways in their respective jurisdictions, to facilitate the purposes of this Act.

SEC. 9. LOCAL SERVICE ROADS.—In connection with the development of any limited access facility the State, county, city, town, or village highway authorities are authorized to plan, designate, establish, use, regulate, alter, improve, maintain, and vacate local service roads and streets or to designate as local service roads and streets any existing road or street, and to exercise jurisdiction over service roads in the same manner as is authorized over limited access facilities under the terms of this Act, if in their opinion, such local service roads and streets are necessary or desirable. Such local service roads [illegible] the limited access facility proper by means of all devices designated as necessary or desirable by the proper authority.

SEC. 10. UNLAWFUL USE OF LIMITED ACCESS FACILITIES, PENAL- [illegible] dividing line on limited access facilities; (2) to make a left turn, a semicircular, or U-turn except through an opening provided for that purpose in the dividing curb section, separation, or line; (3) to drive [illegible] the [illegible] separation section, or line; (4) to drive any vehicle into the limited access facility from a local service road except through an opening provided for that purpose in the dividing curb or dividing section or [illegible] facility proper. Any person who violates any of the provisions of this section is guilty of a misdemeanor and upon arrest and conviction therefor shall be punished by a fine of not less than five dollars ($5.00) nor more than one hundred dollars ($100.00), or by imprisonment in the city or county jail for not less than five days nor more than ninety days, or by both such fine and imprisonment.

SEC. 11. SEVERABILITY.—If any section, provision, or clause of this [illegible] stance, such invalidity or inapplicability shall not be construed to affect the portions not so held or persons or circumstances not so affected. All laws or portions of laws inconsistent with the policy and provision of this act are hereby repealed to the extent of such inconsistency in its application to limited access facilities provided for in this Act.

APPENDIX IV

New York Grade Crossing Elimination Act of 1928

SECTIONS PRESCRIBING LAND ACQUISITION PROCEDURE

Source: McKinney's Consolidated Laws of New York, Annotated, Book 65, Unconsolidated Laws (1942), title 22, sec. 7905; 1943 Cumulative Annual Pocket Part

§ 7905. Acquisition of lands, temporary occupation

1. The public service commission shall direct the department of public works or the railroad corporation or corporations to prepare an accurate description and map of any lands which the commission may deem necessary in the elimination of any crossing or of any land in connection with which an easement right may be deemed necessary, or of any [illegible] which may be deemed by the commission to be necessary, specifying the particular easement right. On the approval of such description and map by such commission, such commission shall deliver such description and map to the department of public works and shall direct such department to acquire such lands and easement rights by appropriation as prescribed by this act.

2. Such description and the original tracing of such map shall be filed in the office of the department of public works, which shall cause a [illegible] the department of state and notice of such filing to be given to the public service commission.

3. On the filing of such description and map in the office of the [illegible] and agents may immediately enter upon and take possession of the lands so described for the purpose of the elimination of any crossing.

a. If the public service commission shall determine, prior to the service of such description and map on the owner or owners of land and easement rights, that changes, alterations or modifications of such [illegible] should be made, it shall direct the department of public works or the railroad corporation or corporations to prepare an amended description [illegible] works and filed in the office of the department of state in the same manner as the original description and map was filed and shall thereupon in all respects and for all purposes supersede the description and map previously filed.

b. If the public service commission shall determine prior to the service of such description and map on the owner or owners of land and easement rights that such description and map should be withdrawn it shall file a certificate of withdrawal in the offices of the department [illegible] the filing of such certificate of withdrawal the description and map to which it refers shall be canceled and all rights thereunder shall cease and determine.

4. The department of public works shall thereupon deliver to the attorney-general a copy of such description and map, whereupon it shall be the duty of the attorney-general to advise and certify to the department of public works the names of the owners of the lands so [illegible] to such lands. The department of public works shall thereupon [illegible] thereof in the office of the department of state, to be served on the owner or owners of the lands and easement rights so certified by the attorney-general and from the time of such service the appropriation by the people of the state of the property described in such notice shall be deemed complete and, thereupon such property shall become and be the property of the people of the state: *Provided, however*, that in the event that the lands or interests therein set forth in such description and map shall be owned by a municipal corporation and used for the purposes of impounding, storing or transporting water [illegible] such appropriation shall be subject to the express condition that the [illegible] danger or injure the water-supply structures or other property of such municipal corporation or interfere with the use and operation [illegible] found within the state. If the department of public works shall not be able to serve such notice or cause the same to be served upon the owner or owners personally within the state, after making an effort so to do which such department shall deem to be reasonable and proper, service may be made by filing such notice, description and map in the office of the clerk or register of the county wherein the property so appropriated is situated, and by causing such notice to [illegible] clerk or register. On the filing of such notice with such clerk or register, it shall be the duty of such clerk or register to record same [illegible] register and to index the name of the person or persons to whom such notice is directed as a grantor in an index book to be kept by such clerk or register; and the record of such notice shall be presumptive evidence of due service thereof.

5. If service be personal, the department of public works shall thereupon cause a copy of such notice, together with an affidavit of due service thereof on such owner or owners, to be filed and recorded [illegible] as aforesaid and it shall be the duty of such clerk or register to record and index same as provided in case service is other than personal, and the record of such notice and of such proof of personal service shall be presumptive evidence of due service thereof.

7. [illegible] damages caused by any such appropriation may be adjusted by the [illegible] upon [illegible] of the elimination, even though a claim has been filed with the court of claims, if the amount thereof can be agreed upon with the owner or owners thereof. Upon making any such adjustment and agreement, the department of public works shall deliver to the comptroller such agreement and a certificate stating the amount due such owner on

account of such appropriation of his land or other property and the amount so fixed shall be paid out of the state treasury from moneys appropriated for such elimination from the proceeds of such state bonds but not until there shall have been filed with the comptroller a certificate of the attorney-general showing the person or persons claiming the amount so agreed upon to be legally entitled thereto, and the railroad corporation or corporations and the county or counties shall pay to the state their proportionate shares as prescribed by this act of any amount so agreed upon as part of the cost of such elimination.

8. Any owner may present to the court of claims a claim for the [illegible] provided by law for the filing of claims with the court of claims. Awards and judgments of the court of claims shall be paid in the same manner [illegible] generally and shall be paid out of the state treasury from moneys appropriated for such elimination from the proceeds of such state bonds, and the railroad corporation or corporations and the county or counties sharing in the cost of such elimination, shall pay to the state their proportionate shares as fixed by this act of any such judgment as a part of the cost of such elimination, and if necessary, the comptroller shall revise or supplement his determination, as prescribed by this act, relative to times, amounts, and manner of repayments to the state by [illegible] bearing a part of the cost of the elimination, so as to provide for the payment to the state of the part of such judgment chargeable hereunder to such corporation or corporations and such county or counties.

9. The expense of such acquisition, including the cost of making [illegible] serving notices of appropriation, making appraisals and agreements and of searches ordered and examinations of title made by the [illegible] and shall be borne in the proportions prescribed by this act.

* * * * * * *

17. If any lands including lands under water, and easement rights, which the public service commission may deem necessary in the elimination of any crossing are owned by the state, such commission shall deliver the approved description and map of such lands and easement rights to the department of public works and shall direct such department to make application to the board of commissioners of the land office for the transfer of the control or jurisdiction of such lands and easement rights to such department for the purpose of accomplishing such elimination. Upon such application being filed, the board of commissioners of the land office may transfer control or jurisdiction of such lands and easement rights to the department of public works for the purpose of accomplishing such elimination upon such terms and [illegible] but such transfer shall not become effective until the said terms and conditions [illegible] or agency which had control or jurisdiction over such lands and easement rights.

[illegible] of such lands and easement rights to be filed in the office of the department of state, and shall notify the public service commissioner of such filings.

18. Notwithstanding any other provision of this chapter and the acts supplemental thereto, [illegible] general or special a municipal corporation may grant a permit to the department of public works to occupy, for grade crossing elimination purposes, any of the lands set forth and described on the map prescribed by [illegible] cipal corporations, respectively. Such permit may be for permanent [illegible] public works, and the permit shall state the purposes for which the [illegible] payment, if any, which is to be made under the permit. The permit shall be in lieu of an appropriation of land as provided in this act. After approval by the public service commission such permit shall be in force and the lands may be utilized by the people of the state of New York, their officers and agents, or by any railroad corporation to [illegible] for such elimination from the proceeds of such state bonds, after the department of public works has filed a copy of the approved permit with the comptroller. The railroad corporation or corporations and the county or counties shall pay to the state their proportionate shares as prescribed by this act of the amount specified in the permit.

19. If, at or after the expiration of thirty days from the service of the copy of such description and map and notice of the filing thereof in the office of the department of state, the superintendent shall deem it necessary to cause the removal of an owner or occupant from any lands or easement rights so acquired, he may cause the owner or occupant to be removed therefrom and the possession to be delivered to him in the same manner and by the same proceedings and before the [illegible] tion of his term without permission of his landlord, except as follows: the petition shall be preceded by ten days' notice to quit, in the form [illegible] sixteen of the civil practice act, and the giving of such notice shall be stated in the petition. The proceedings shall be brought in the name of the superintendent as agent of the state. If any person proceeded [illegible] answer raising any material issue, the attorney-general shall be notified and he thereafter shall represent the petitioner in the proceedings. No execution shall issue for costs, if any, awarded against the state or [illegible] tion and be paid in like manner. Proceedings may be brought separately against one or more of the owners or occupants of the lands or [illegible] several of the owners or occupants of any or all the lands or easement rights within the territorial jurisdiction of the same justice or judge; and in any case precepts or final orders shall effect or be made for immediate [illegible] withdrawing their answers, if any, without awaiting the trial or decision of issues raised by contestants, if any. L. 1928, c. 673, §6, amended L. 1929, c. 645, §§ 4, 5, L. 1929, cc. 647, 657, L. 1931, c. 711, L. 1933, c. 692, L. 1937, c. 585, §§ 1, 2, L. 1940, c. 101, eff. March 7, 1940.

[illegible]

APPENDIX V

Basic Standards of Road and Structural Design

BASIC STANDARDS FOR RURAL SECTIONS

I Roads

Condition of access.—All rural sections of the system shall be established [illegible] permitted only at designated points at which facilities for safe entrance and exit shall be provided. The [illegible] structures.

On all rural sections of the system expected to carry an average daily traffic of 5,000 or more vehicles there shall be no crossings of other highways at grade [illegible] highway shall be carried over it or under it by means of adequate structures.

Wherever feasible on all rural sections of the system expected to carry an average daily traffic of less than 5,000 vehicles, grade intersections of [illegible] must cross the interregional highway shall be carried over or under [illegible] tion of a highway intersection is not immediately feasible, all necessary provision shall be made in the initial design for future conversion to the improved design when financially feasible. This initial provision shall include [illegible] tion of control of the use and improvement of private property essential to conversion to the improved design. Where separation of grades at highway intersections is not feasible, and at all points where vehicles may be expected to cross, enter, or leave the interregional highway, the design shall be such as to insure a high degree of safety in crossing, entering or leaving it, without installation of [illegible].

Location.—The location between control points shall be as direct as feasible and shall conform to the topography in such manner as to avoid the appearance of forced alinement. Where four or more traffic lanes are to be constructed, two distinct one-way roads should be provided rather than a divided highway of fixed cross section, wherever advantages of alinement, construction cost, or traffic facility may be expected to result from such provision.

Alinement.—Alinement of rural sections of the system shall be of as high a standard as feasible and the speed assumed for design purposes for a section of road shall be as high as practicable, consistent with the [illegible]. The [illegible] assumed for adjacent sections of the highway shall not differ widely.

Horizontal curvature.—Horizontal curvature shall be under all conditions of the lowest practicable degree, and at no point sharper than the degree shown in the column headed "Absolute maximum" in the

following table [illegible] to the design speed assumed for the section. [illegible] are shown in the column headed "Desirable maximum."

Table 1.—*Maximum horizontal curvatures at various design speeds (rural)*

Design speed of section	Curvature limits			Curvature limits	
	Absolute maximum	Desirable maximum		Absolute	Desirable
	Degrees	Degrees		Degrees	Degrees
75 miles per hour	3	2.5	60 miles per hour	5	3
70 miles per hour	4	3	55 miles per hour	7	5
65 miles per hour	5	4	50 miles per hour	9	7

[illegible] lower degrees than that shown in the above table may be [illegible] most exacting circumstances requirements where a cut slope or [illegible] length of the transition.

Superelevation of curves.—All curves sharper than 1 degrees shall be [illegible] 0.12 for [illegible] Where snow and ice may be expected to cause a frequent [illegible] not exceed [illegible] elevation shall be attained gradually, and in such [illegible] shall be [illegible] as will provide [illegible] continuously unobstructed view for the following [illegible] the top of an object 4 inches high placed on the road surface.

Table 2.—*Minimum nonpassing sight distances that shall be provided at various design speeds (rural)*

Design speed of section	Minimum nonpassing sight distance
75 miles per hour	800 feet
70 miles per hour	700 feet
[illegible]	600 feet
[illegible]	525 feet
55 miles per hour	450 feet
50 miles per hour	400 feet

[illegible]

Within these sight distances passenger vehicles as presently constructed can [illegible] the speed shown at the [illegible] combinations can be stepped from speeds ranging from 60 miles per hour where the sight distance is 400 feet to about 50 miles per hour where the sight distance is 800 feet.

On rural two-lane sections of the system, whenever it is financially feasible to do so the road shall be so

TABLE 3.—*Minimum sight distances for passing at various design speeds (rural)*

Design speed of section	Minimum sight distance for passing
65 or 70 miles per hour	2,400 feet
60 miles per hour	2,200 feet
55 miles per hour	1,800 feet
50 miles per hour	1,500 feet

[1] Between points 3.5 feet above the road surface

On sections so designed drivers of vehicles moving at the design speed will have the assurance of sufficient length of road ahead of any oncoming vehicle in view in which to accomplish the passing of another vehicle moving in the same direction [illegible] sections of roads generally cannot be considered safe, unless the vehicle passed is traveling at a speed considerably slower than that of the passing

On rural two-lane sections of the system expected to carry an average daily traffic volume of 2,000 [illegible] feasible to provide the minimum passing sight distance recommended [illegible] other two-lane sections of the system where the provision of recommended minimum passing sight distance is not [illegible] design speed and in other ways to provide for [illegible]

[illegible] of the system expected to carry an average daily traffic of 5,000 or more [illegible] moving in each direction, each lane to have a width of [illegible]

On rural sections of the system expected to carry an average daily traffic of 2,000 to [illegible] lanes for traffic moving in each direction, each lane to have a width of 12 feet, and the [illegible] which permit crossing or entering at grade at intersecting highways or private entrances [illegible] be at least 40 feet wide, and opposite private-property entrances at least 25 feet

All rural sections of the system expected to carry an average daily traffic of 2,000 to [illegible] less than 5,000 vehicles shall provide a two-lane pavement 24 feet wide. On all parts of such highways where it is not feasible to provide a sight distance at least equal to the [illegible] design of the

Each lane shall have a width of 12 feet, and the lanes for traffic moving in opposite directions shall be separated by a median strip at least 4 and preferably 15 feet wide. The conversion from two to four lanes shall be safely graduated and appropriately and conspicuously marked.

All rural sections of the system expected to carry an average daily traffic of less than 2,000 vehicles shall provide a two-lane pavement 24 feet wide.

Transitions of median-strip width.—Where narrowing or widening of the median strip is necessary essential pavement alinement changes shall be accomplished over lengths sufficient to avoid hazardous [illegible] operation at the design speed assumed and to avoid the appearance of [illegible] shortened or forced alinement.

Width of shoulders and gutters or ditches.—The shoulder width shall be considered as the transverse distance from the edge of the roadway surface or pavement to the inside of the guard rail or, in the absence of a guard rail, to the beginning of rounding into the slope of the embankment or the inside slope of the gutter or ditch.

On rural sections of the system the shoulder width shall be 10 feet [illegible]

(a) In mountainous topography where for reasons of expense a 10-foot width is not feasible.

(b) Where the two roadways of a divided highway are widely separated or constructed at different elevations and left shoulders are required the width of such left shoulders may be less than 10 feet.

In no case shall the shoulder width be reduced to less than 4 feet.

In excavation gutters or ditches of adequate capacity shall be constructed outside of the shoulder width provided and the slope from the edge of the shoulder shall be not steeper than 1 foot measured vertically to 4 feet measured horizontally.

Side slopes in excavation and embankment.—In general, the sides of all excavations except in solid rock shall have a slope not steeper than 1 foot measured vertically to 2 feet measured horizontally, modified as deemed desirable to meet landscape requirements. The sides of all excavations shall be rounded at the top and bottom to merge by curves of natural appearance into the slopes of the adjoining land and those of the gutter or ditch. At the ends of sections in excavation the side slopes shall be flattened as the depth of excavation decreases.

The sides of all embankments 10 feet or less in height shall have a slope not steeper than 1 foot measured vertically to 4 feet measured horizontally, except where the adjoining land lies on a steeper downward slope or where landscape considerations may justify modification of this requirement.

All embankments more than 10 feet in height and all embankments built on ground having a natural downward slope steeper than 1 foot [illegible] not steeper than 1 foot measured vertically to 2 feet measured horizontally, except where the adjoining land lies on a steeper downward slope, in which case slope protection or a retaining wall shall be constructed.

Gradient. The gradient of rural sections of the system shall be [illegible] and the rate of rise necessarily

for passing trucks and tractor combinations, with maximum limits under various conditions as given in table 4.

TABLE 4.—*Maximum gradient limits under various traffic volumes and topographical conditions (rural)*

Average daily traffic (all vehicles)	Maximum gradient limits (percent)		
	Rolling	Hilly	Mountainous
Less than 1,000	5	6	7
1,000 to 2,000	4	5	6
2,000 to 3,000	4	5	6
3,000 to 5,000	3	4	5
5,000 and more	3	4	5

[illegible] on the 2-lane highways to be provided for this volume of traffic, in order to permit the maximum feasible speed of trucks and tractor combinations and correspondingly reduce the frequency of passing.

[illegible] limit permissible because a divided 4-lane highway is to be provided for this volume of traffic where minimum passing sight distance previously recommended is not feasibly obtainable, thus providing passing of slow moving trucks and tractor combinations at all grades.

[illegible] limit, permissible because a continuously divided 4-lane highway is [illegible] of traffic. Has permitting easily passing of [illegible] [illegible] limitations in the number to be [illegible]

[illegible] limits desirable because of the [illegible] number of [illegible] to be depended upon the consequent necessity to permit the maximum feasible speed of such vehicles to reduce the frequency of passing.

[illegible] existing roads conforming to the recommended interregional system in mountainous topography carried only small traffic before the war.

In general, extremely long grades should be [illegible] and very short grades [illegible] one-way roads may be steeper, than the limits given in table 4, but none shall exceed 7 percent.

Width of right-of-way. [illegible] the width of right-of-way [illegible] shall be sufficient [illegible] the road surfaces or pavements and median strip, the shoulders, gutters, or ditches, and the side slopes of the road, constructed in accordance with the foregoing recommendations with full allowance for the widening and conversion of the traveled way and other cross-section features estimated to become necessary within a period of 20 years.

In addition, public control should be obtained, either by purchase or outright condemnation, [illegible] requirement of highway development rights, over a strip of land of sufficient width to prevent the erection of any private structure or sign within [illegible] less than 100 feet from the edge of the road surface or pavement [illegible] to be constructed or reconstructed within a period of 20 years.

Substantial conformity with these right-of-way standards will require the elimination of [illegible] not to any greater degree determined to be necessary, over a strip of land not less than 224 feet wide in the case of the most highly traveled sections of the system to be improved ultimately with two-lane surfaces or pavements and not less than 288 feet in all other cases.

Wherever feasible, it is desirable on rural sections of the system that public control be obtained at the outset over a strip of land 300 feet wide without regard to the expected traffic volume on the highway.

Where it is necessary at the time of construction or where it will probably be necessary at a later date to provide service roads to permit use of the interregional highway as a limited-access highway, sufficient width for the construction of such service roads shall also be included in the width of right-of-way to be initially acquired.

Foundations and bases. All road foundations and bases on rural sections of the system shall be capable of supporting the recommended maximum load of vehicles on such roads at [illegible] by surfaces or pavements of adequate design, without reduction of load or speed at any season of the year.

Surfaces and pavements.—All road surfaces and pavements on rural sections of the system shall consist of such material and shall be of such thickness as will enable them, when placed on bases and foundations of adequate design, to support the recommended maximum loads of vehicles, without reduction of either load or speed at any season of the year, [illegible] traffic of the [illegible] weight, speed, and volume, with a reasonable expenditure of maintenance effort, a uniformly dustless, mudless, and smooth but skid-resistant surface.

Shoulders.—All road shoulders on rural sections of the system shall contrast in texture and preferably in color with the adjoining surface or pavement. They shall be capable of supporting the recommended maximum loads of vehicles standing on them or passing onto them infrequently and in emergency at high speed, and shall be capable of retaining under such usage, with a reasonable expenditure of maintenance effort, a reasonably mudless and even surface, without dangerous difference of level [illegible] with the road surface or pavement.

11 Bridges and culverts.

Definitions.—All structures of a length between abutments greater than 20 feet, measured along the center line of the road, shall be defined as bridges.

All bridges of a length between abutments greater than 100 feet shall be classed as long bridges.

All bridges of a length of 100 feet or less shall be classed as short bridges.

All structures of a length between abutments of 20 feet or less measured along the center line of the road, shall be defined as culverts.

Alinement of bridges. All bridges, wherever feasible, shall be so located as to fit the over-all alinement and gradient of the highway and shall be subordinated thereto. Where structural or architectural requirements make it desirable to adjust the alinement and gradient of the highway, the changes shall be such that the highway will meet all the basic standards for rural sections of the system, recommended herein under "I. Roads."

Width of bridges. The width between vehicular curbs on all bridges built on tangents of rural sections of the system shall be at least 6 feet greater than the width of the surface or pavement of the approach highway, and the lateral distances between the edges of the pavement of the approach highway and the faces of the vehicular curbs shall be

On all bridges the lateral distance from the face of the curb to the face of the bridge rail or any structural member shall be at least 18 inches and as much more as is necessary for walk space, which shall be provided on all long bridges.

On short bridges the [illegible] from the edge of the pavement of the approach highway to the face of the bridge rail, any structural member, or curb shall be not less than the width of shoulder on the approach highway.

On sections of the system improved with divided highways, one bridge to accommodate both roadways and the median strip or two separate bridges, each to accommodate one roadway, may be used. On short bridges [illegible] shall be accommodated without [illegible] and on long bridges the two roadways shall be so accommodated if feasible.

Where, on long bridges, the median strip is reduced in width, the change in alinement shall be accomplished in such manner and over [illegible] as will [illegible] as conducive to the design speed and the appearance of distorted or forced alinement. Where the median strip is reduced in width over structures the two roadways shall be separated [illegible] by a median strip not less than 4 feet wide.

Auxiliary lanes on bridges.—Where auxiliary lanes or designs for other purposes provide a pavement at grade crossings that extends beyond the normal edge of the traffic lanes, the face of abutment walls and other support shall be at least 4 feet outside the edge of the widened pavement on the approach.

Bridges on curves.—On all bridges on curves the clearances shall be [illegible] specified for tangent bridges, and the minimum clearance to the face of the bridge rail or any structural member shall be as much more as shall be necessary to maintain the minimum sight distance [illegible] of the ways on which the bridge is located.

Clear height of bridges.—The clear height of all bridges over the entire width between outer curbs shall be not less than 14 feet.

Openings under bridges.—All bridges over railways shall provide a clear height and length between abutments to be determined by agreement with the railway companies concerned.

All bridges over public roads or highways shall provide a clear [illegible] between [illegible] not less than the sum of the widths of the surfaces or pavements, median strip and shoulders or sidewalks of the underpassing road or highway, such distance to be [illegible] of the [illegible] may be founded within the median strip of a divided underpassing highway if the sides of such [illegible] parallel to the underpassing highway are not less than 4 feet from the inner edges of the adjacent pavements. All bridges over roads or highways shall provide a clear height above the surface or surfaces of the underpassing road or highway of not less than 14 feet and [illegible] less than 3 feet above the outer edges of the shoulders of such highway.

Pavements on bridges.—All portions of bridge pavements, between lines joining the edges of the pavements of the approach highways at the bridge, shall be of a color identical with that of the pavement on the approach highway. The color of portions of bridge pavements outside of such lines shall approximate the color of the shoulders of the approach highways.

Structural design of bridges.—All bridges constructed on rural sections of the interregional highway system shall be of steel or reinforced concrete and shall be designed for the loadings H20-S16 design loadings specified by the American Association of State Highway Officials as defined in appendix VI. All short bridges shall be of deck construction, and long bridges shall preferably be of [illegible] construction.

Width of culverts.—The over-all clear width of all culverts shall be equal to the sum of the widths of the surfaces or pavements, median strip, and shoulders of the section of the interregional highway in which they are installed.

On divided highways the two roadways shall be separated over culverts, by a median strip of the width provided on the highway approaching the culvert. In the case of [illegible] headwall with earth embankment the slopes shall be carried over the culvert, identical in design with the shoulders and slopes of the approach highway.

In all other cases the entire clear width shall be paved, and, between lines joining the [illegible] of the pavements of the approach highways to the culvert, such paved areas shall be separated with [illegible] of the pavement of the approach highway. A cross section of the pavement over culverts outside of such lines shall approximate the color of the shoulders.

Structural design of culverts.—All culverts on rural sections of the interregional system shall be constructed of reinforced concrete or stone masonry. If of concrete, the mix shall be of proportions of suitable quality of not less than [illegible] bags to all cubic yards. Regardless of the material adopted, shall be designed to carry with safety the [illegible] H20-S16 design loadings and the weight of any [illegible] embankment. Such loads and weights are [illegible] to the supporting structure.

III. Underpasses.

Clear width of underpasses.—All underpasses on rural sections of the system shall provide a width for passage of the highway equal to the sum of the widths of the surfaces or pavements, median strip, and shoulders of the approach highway, plus [illegible] underpass walls, but the [illegible] of the [illegible] may be [illegible] of the median strip of a divided highway, but the sides of such pier, parallel to the [illegible] of the roadway, shall be not less than 18 inches from the faces of [illegible] which shall be not less than 3 feet from the edges of the pavements of the interregional highway.

Where provision is to be made for walks, the space may be provided in the clear width provided for the highway or may be provided beyond the supports adjacent thereto.

Auxiliary lanes at underpasses.—Where auxiliary lanes or designs for other purposes provide a pavement at underpassings that extends beyond the normal edge of the traffic lanes, the face of abutment walls or other support shall be at least 4 feet outside the edge of the widened pavement.

Widening at underpasses at curves.—Underpasses on curves shall be widened to the extent necessary to provide, for traffic on curves, by any combination of widening and set-back, sight distance used in the design of the section of the interregional highway on which the underpasses are located.

Length of underpasses.—The length of underpasses shall be such as to provide adequate bridge width for the full width of the crossing railway or public highway. The bridge width to be provided for railways shall be determined by agreement with the railway companies concerned. The bridge width to be provided for highways shall be determined in the manner as previously prescribed for underpasses of like length on rural sections of the interregional system.

Clearance height of underpasses.—All underpasses on rural sections of the system shall provide a clear height of not less than [illegible] feet above the highest point of the pavement and not less than 2 feet above the edge of the shoulder of the highway.

Separation of railway tracks.—Where railways cross over rural sections of the interregional highway, the railway tracks shall be separated from the highway roadways by adequate [illegible] All underpasses on highways shall be designed in agreement with the authorities in charge of such highways, but in no case for less than the standard H-20 loading specified by the American Association of State Highway Officials and described in appendix VI.

IV. Access facilities.

Rural sections of the system shall be designed, wherever feasible, for the provision of access to the interregional highway at the more important intersecting roads.

Direct interchanges.—Where, at points of access on rural sections of the system, the interregional highway is expected to carry an average daily traffic of [illegible] vehicles, access shall be provided by means of [illegible] with ramps or connections between the [illegible] roads. Access will be provided by means of [illegible] highway by means of [illegible] roadways separated at the points of crossing with other roadways.

Right-turning access at grade-separated intersections.—Where, on [illegible] access is to be provided from intersecting roads, and the provision of direct connections for left- and right-turning movements is not feasible, ramps or connections between the [illegible] to the interregional highway for right-turning movements only. Wherever feasible such ramps or connections shall be provided in the four quadrants of the intersection, each to accommodate traffic moving from or to the interregional highway to or from the lanes for traffic in one direction on the intersecting highway. If such provision is not feasible, ramps or connections for right-turning movements only shall be provided in at least two of the four quadrants of the intersection, one on each side of the interregional highway, and wherever topography will permit, in the nearer quadrant for traffic approaching the intersection on the interregional highway.

Where, on rural sections of the system expected to carry an average daily traffic of 2,000 but less than 3,000 vehicles, grades are separated and access facilities are to be provided, the interregional highway shall be widened to provide two lanes for traffic moving in each direction, the lanes for traffic moving in opposite directions shall be separated by a median strip at least 4 and preferably 15 feet wide, and ramps or connections between the intersecting roads shall be provided in the same manner as at grade-separated intersections with access facilities, on sections of the system designed with 4 or more traffic lanes.

Where, on rural sections of the system expected to carry an average daily traffic of less than 2,000 vehicles, grades are separated and access facilities are to be provided, the ramps or connections between the intersecting roads shall be constructed in such manner as to permit exit from or entrance to the interregional highway by right-turning movements only.

Access at crossings at grade.—Where on rural sections of the system designed with four or more through-traffic lanes, access is to be provided from an intersecting highway and it is not deemed financially feasible immediately to separate the grades of the intersection, separate channels shall be provided for all right-turning movements, the median strip of the interregional highway shall be not less than 40 feet wide at the intersection, and adequate space shall be provided for all crossing and left-turning vehicles to stop clear of the through-traffic lanes and proceed across the interregional highway or merge with and change from the through traffic moving on the highway in safety. (See plate VII.)

Where on rural sections of the system expected to carry an average daily traffic of 2,000 but less than 3,000 vehicles, access is to be provided from an intersecting highway and it is not deemed financially feasible immediately to separate the grades of the intersection, the interregional highway shall be widened to provide two lanes for traffic moving in each direction, the lanes for traffic moving in opposite directions shall be separated by a median strip at least 15 feet wide, and the intersection shall be [illegible] crossings on sections of the system designed with four or more traffic lanes.

Where on rural sections of the system expected to carry an average daily traffic of less than 2,000 vehicles access is to be provided from an intersecting highway, and it is not deemed financially feasible to separate the grades of the intersection, the intersection shall be designed to provide adequate space for right-turning vehicles safely to merge with and change from the through traffic on the interregional highway. Such space shall also be sufficient to permit vehicles turning left from the interregional highway to halt if necessary at the center of the intersection before completing the turning maneuver and to permit through traffic to pass such halted vehicles in safety.

Alinement of ramps or connections.—Ramps at grade-separated intersections on rural sections of the interregional system shall preferably be designed as one-way roads separated for the whole length of ramp. Where two-way ramps are used entrances and exits at the interregional highway and, if deemed feasible, at the

intersecting highway also shall be designed as one-way roads separated by [illegible] at sufficient distances from the grade-separating structure to provide sight distances adequate for safety under the conditions of vehicular speed to be anticipated

All ramps and connections shall be designed to enable vehicles to leave and enter the through-traffic lanes of each highway at 0.7 of its design speed, except where "stop" control is necessary. On all four-[illegible] an average daily traffic of more than 2,000 vehicles, and wherever feasible on all other two-lane sections, the curvature of ramps and connections shall preferably not exceed 45 degrees (radius approximately 125 feet), and under no conditions shall exceed 70 degrees (radius approximately 80 feet). All curves shall be eased by transition or compounding

Widths of pavements and shoulders and side slopes.—All ramps and connections shall have a width of at least 16 feet if designed for one-lane operation, and at least 26 feet if designed for two-lane operation. Widths greater than these maxima shall be provided on sections of ramps and connections of sharp curvature.

A shoulder at least 6 feet and preferably 8 feet wide shall be provided along the right side of all ramp pavements (right in the direction of traffic movement)

Side slopes on ramps shall be not steeper than 1 foot measured vertically to 2 feet measured horizontally and shall be rounded at the top and bottom to merge by curves of natural appearance with the adjacent land slopes or shoulders.

Added space for turning maneuvers.—All rural sections of the system shall be so designed, at the approach to entrances and exits on the [illegible] and entering vehicles to accelerate, and, in general, to maneuver as [illegible] traffic stream. The added space may take the form of a taper, a pavement gradually increasing in width, or a taper combined with a zone of full added width. Tapers shall be smoothly aligned and of a length consistent with probable speed of travel. Where a full width of added [illegible] and feasible, similar provision shall be made on the intersecting highway

Where an exit to an inner loop is provided on one side of a grade-separating structure and an entrance from an inner loop is provided on the opposite side of the structure, an added lane shall be carried over the bridge or through the underpass to connect both inner loops and serve as added space for the maneuvers of entering and leaving the interregional highway.

At exits from a through-traffic lane, added width of pavement and a taper shall be provided beyond the nose at the fork to enable vehicles which start to turn off to return safely and conveniently to the through-traffic lane if desired. A curb of high visibility should be used around the nose at the fork and along these widened pavements.

All pavement surfaces of ramps and connections and all added pavement width provided for maneuvering shall contrast in color [illegible] preferably [illegible] the pavements of the through traffic lanes.

Gradients on ramps.—The gradient on ramps shall not exceed 6 percent on upgrades and 8 percent on downgrades

Sight distance at ramps and connections. On all ramps and connections the combination of grade, vertical curves, alinement, and clearances of lateral and corner obstructions to vision shall be such as to [illegible] their terminal junctions along the interregional highway and intersecting [illegible] operation.

At all grade intersections on rural sections of the interregional system, [illegible] shall be required before crossing the interregional highway, to come to a complete stop at a point off the through-traffic lanes of the interregional highway. From such point of stopping, the sight distance in each direction along the interregional highway and from the rear [illegible] way, as hereinbefore recommended

Access for buses [illegible] of the interregional system. Access connections for bus stops off the interregional highway shall be designed to the same standards as [illegible] connections.

[illegible] system. Access connections for [illegible] highway shall be designed to the same standards as other access connections

V. Tunnels.

Tunnels on rural sections of the interregional highway system shall [illegible] not less than 10 feet greater than the pavement or surface width of the highway approaching the tunnel, to provide for the 2-foot center separation and not less than 4-foot side clearances beyond the [illegible] he pavement

[illegible] the same number of lanes as the approaches, in either a single or twin bore. In the former case the lanes for traffic in opposite directions shall be separated by a [illegible] than 4 feet wide; and the over-all width of the tunnel shall provide [illegible] in addition to the aggregate width of traffic lanes of the same number and width as on the highway approaching the tunnel. In the case of [illegible] provided on the highway approaching the tunnel.

[illegible] across the entire paved width

[illegible] without previously recommended [illegible]

Wherever their length requires, all tunnels shall be artificially ventilated and lighted in such manner as to provide ample safe conditions

of air and light. For an appropriate distance inward from the portal the intensity of artificial light provided during the day shall be sufficient to afford such a transition between outer daylight and the normal tunnel lighting as will permit safe entrance into the tunnel without reduction of the speed of vehicles.

VI. Pedestrian facilities.

On rural sections of the system pedestrian use of road surfaces and pavements and shoulders shall be prohibited. Adequate pedestrian paths shall be provided whenever the need justifies.

Wherever other public highways are carried over or under a rural section of the interregional system, provision shall be made for safe pedestrian crossing of the interregional highway, if necessary, by means of adequate walkways along the [illegible] overpassing highways or overpassing bridges. At other points where [illegible] is [illegible], special pedestrian underpasses or overpasses with connecting walkways shall be provided.

VII. Landscaping.

On all rural sections of the system the design, wherever feasible, shall [illegible] necessary [illegible] landscape [illegible] [illegible] preserve [illegible] of [illegible] other [illegible] Unnecessary [illegible] shall be [illegible]. Borrow pits shall not be [illegible] with [illegible] of the road [illegible] and [illegible] covered [illegible]. All ground surfaces disturbed by construction shall be appropriately recovered with suitable vegetative growth, and additional landscaping shall be done where [illegible] necessary.

The [illegible] with recovering of disturbed surfaces and [illegible] landscaping shall be [illegible] to protect the highway against erosion by wind and water, to reduce [illegible] and to enhance the natural appearance of [illegible] the wayside.

VIII. Signs and pavement markings.

The design of rural sections of the interregional system shall be such as to reduce to a practicable minimum the necessity for cautionary signs and pavement markings. The installation of traffic control signals shall be prohibited.

The form, dimensions, color, and style and size of all lettering of all signs, the legend of all cautionary signs, and the form, dimensions, [illegible] of all pavement markings shall be uniform throughout all rural sections of the interregional system in all States.[1]

Route markers. It is recommended that all interregional highways be incorporated in the United States system of numbered highways and that all rural sections of the system be marked with standard U S route markers, appropriately illuminated or reflectorized for night visibility. If two or more U S numbered routes incorporate the same section of any interregional highway, standard U S route

[1] It is recommended that the details of design of all signs and pavement markings, as herein generally described, be defined by the [illegible] Association of State Highway Officials, the Institute [illegible] Street and Highway Safety, and that signs and markings [illegible] be adopted and used on all parts of the interregional system in all States.

markers designating each route shall be erected on the section so incorporated, but no route markers other than standard U S route markers shall appear on any interregional highway, except at points of exit.

Destination signs. On rural sections of the system, all points of entrance or exit [illegible] at grade-separated intersections with other highways shall be designated as "interchanges," and each shall be identified by the name of a single nearby important city or area within a city or by the number of the intersecting highway. Warning of approach to an interchange shall be provided by a sign located at a suitable distance in advance of the interchange, bearing the legend "(Name) interchange ahead."

At each point of turning at each interchange a sign shall be provided bearing the name of a single nearby important city or locality served by the intersecting highway with which the particular ramp [illegible] or the number of the intersecting highway and direction if no geographical name is appropriate, or both if necessary. Immediately beyond the interchange on the interregional highway [illegible] U S route marker [illegible], and [illegible] sign showing the distance to the next important city or interchange. The size, legibility, and location of all such signs shall be appropriate for the conditions of placement and probable speed of traffic on the interregional highway.

Except as above recommended, no direction or distance [illegible] shall be given at interchanges by signs on the interregional highway. Such additional directions and distances as may be [illegible] desirable shall be indicated by signs located at the junction of the ramp with the intersecting highway.

At interchanges that are lighted at night, all such signs located on the interregional highway shall be illuminated. At other interchanges all signs shall be illuminated where feasible, or if not illuminated shall be reflectorized.

Signs at grade crossings. At important grade intersections with other highways, a similar system of signing shall be used on the interregional highway, modified as necessary to indicate also important nearby cities or localities, or highway number and direction, or both, in the direction of permitted left turns as well as right turns. Warning signs preparatory to such turns shall bear the legend "U S (or State) route number ahead." On all highways intersecting interregional highways, appropriate signs and marking shall be installed to provide necessary information for traffic approaching the interregional highway and to assure the maximum degree of safety to approaching traffic and to traffic on the system.

Where traffic is required to come to a full stop before entering or crossing an interregional highway, a stop line shall be marked on the pavement of the intersecting highway and a standard stop sign bearing the legend "Express highway" shall be erected.

Whether or not a stop sign is required there shall be erected at an appropriate advance location on the intersecting highway a warning sign bearing the legend "Express highway ahead."

All stop lines shall be reflectorized, and all stop and warning signs shall be illuminated where feasible and, if not illuminated, shall be reflectorized.

At intersections of insufficient importance to require destination signs, a distinctive sign shall be erected at a suitable distance in advance to indicate merely the approach to a minor intersection.

Speed control signs. Wherever the design of the interregional system permits for [illegible] safe speed less than 70 miles per hour the following signs shall be provided

At the beginning of a section on which the maximum safe speed under normal conditions is between 60 and 70 miles per hour, there shall be erected a sign bearing the legend, "Maximum speed 60," and signs of this character shall be repeated at approximately 1-mile intervals throughout the section. At such point as a 70-mile speed again becomes safe a sign shall be erected bearing the legend "Maximum speed"

At the beginning of a section on which the maximum safe speed under normal conditions is between 50 and 60 miles per hour there shall be erected a sign bearing the legend "Maximum speed 50," followed by similar signs at approximately 1-mile intervals throughout the section. At the end of such section one of two signs shall be used, (1) if 70 miles per hour is again safe a sign bearing the legend "Maximum speed," or (2) if the section terminates in a section on which the maximum safe speed is between 60 and 70 miles per hour, a sign bearing the legend "Maximum speed 60," followed by similar signs throughout that section

Where the traffic conditions anticipated at interchanges on rural sections of the system require reduction in speed below 50 miles per hour the safe speed shall be [illegible] at the beginning of each such reduced-speed section, bearing the legend "Slow to ——," with following signs located at appropriate intervals throughout the section, bearing the legend "Speed ——." The end of such a reduced-speed section shall be [illegible] the safe speed [illegible] the highway.

Where State or local traffic regulations, rather than alinement of the highway or traffic conditions govern the maximum speed, such maximum speed limits shall be indicated at appropriate intervals by signs bearing the legend "Speed limit ——."

All speed control signs shall be illuminated for night safety, except at points where artificial illumination is preferable and feasible

Signs to control or prohibit passing.—At the beginning of any rural two-lane section of the system on which the sight distance is insufficient for safe passing [illegible], there shall be erected a sign bearing the legend, "Passing unsafe," and similar signs shall be erected at approximately one-half mile intervals throughout the length of the section

At the beginning of any rural two-lane section of the system on which the sight distance is less than 1,000 feet, there shall be erected a sign bearing the legend, "No passing." At the end of such section there shall be erected a sign bearing the legend, "End no passing zone."

Sections on which passing is unsafe or prohibited shall be indicated independently for each direction.

Pavement markings. All pavement markings shall be reflectorized

A. Lane lines On rural two-lane sections of the system there shall be a continuous 4-inch, white center line. On all four- and six-lane divided sections the lanes shall be defined by 4-inch, white dashed lines.

Arrows, route numbers, or other pavement markings may be used when required, particularly on four- and six-lane sections, to supplement directional or other signs, but no warning or direction shall be conveyed by pavement marking alone.

B. No-passing zones On rural two-lane sections of the system a 4-inch barrier line, preferably yellow, shall be marked on the pavement parallel and adjacent to the center line wherever the sight distance is less than 1,000 feet. Such barrier lines shall be marked independently for each direction of traffic and shall be placed on the right of the center line in the direction of traffic affected Barrier lines shall be used in conjunction with "No passing" signs above recommended.

C. Special treatment at interchanges Where, on multilane sections, it is desirable to confine traffic to particular lanes, as at interchanges, continuous white lines shall be used in lieu of dashed lane lines.

Location and information signs.—The use of location and information signs shall be confined to points of [illegible] importance or significance. Such signs shall be of such size and shall be so located as not to detract from, or confuse the significance of other signs as herein recommended.

Discouragement of other signs and markings.—On rural sections of the interregional system that are designed in accordance with the standards [illegible] it is [illegible] that the use of signs and the marking of pavements, except as above proposed, be strongly discouraged.

IX. Lighting

At all points on rural sections of the system where traffic speeds are required to be reduced [illegible] traffic or where unusual degree of caution is required because of traffic or other conditions, the interregional highway and, as necessary, its connections, shall be lighted by fixed source illumination to provide adequate degree of safety and convenience of movement at night. In all such cases appropriate transitional illumination between the lighted and unlighted sections shall be provided

It may also be desirable to illuminate throughout their length rural sections of the system expected to carry large volumes of traffic particularly if the traffic includes a large percentage of commercial vehicles.

X. Provision for public utilities.

The erection of electric light, power, and telephone poles within the right-of-way of rural sections of the system, except those necessary for service of the highway or its appurtenant facilities, shall be discouraged

The construction of underground electric conduits and the laying of water-supply and sewerage pipes and pipes for other public-utility purposes, within the right-of-way of rural sections of the system except those necessary for the service of the highway or its appurtenant facilities, shall likewise be discouraged. Where it is necessary to use the right-of-way of the system for electric facilities, underground construction shall be preferred to the erection of pole lines. Wherever underground electric, water, sewerage, or other facilities are constructed within the right-of-way they shall in no case be constructed, except for crossing the highway, beneath any portion of the right-of-way to be used immediately or eventually for the construction of a pavement.

XI. Fences

Wherever necessary for protection against unauthorized entry by vehicles or pedestrians or for the exclusion of animals, fences of adequate design shall be erected on rural sections of the system, at one or both sides of the highway, on suitable lines within or at the limits of the right-of-way.

BASIC STANDARDS FOR URBAN SECTIONS

I. Roads

Condition of access.—All urban sections of the system shall be established as limited access highways and access to the highway shall be permitted only at [illegible] points at which [illegible] for safe entrance and exit shall be provided. On urban sections of the system there shall be no crossings of railways or other streets and highways at grade. All [illegible] of grade intersections shall be accomplished by means of adequate structures.

Location.—The location between control points shall be as direct as feasible, shall affect [illegible] property as [illegible] as possible, and [illegible] to the topography and property improvements in such manner as to avoid the appearance of forced alinement. Consideration should be given to providing two [illegible] roadways [illegible] rather than a divided highway of fixed cross section.

Elevation and depression of interregional highways.—Wherever, on urban sections of the system, to avoid frequent [illegible] with other streets and highways it is necessary to [illegible] of [illegible] the interregional highway [illegible] [illegible] generally shall [illegible] preferred to elevation.

Elevation of the interregional highway shall be employed as a means of avoiding frequent grade intersections with other streets and highways [illegible] [illegible] right-of-way [illegible] the highway [illegible] generally shall [illegible] [illegible] design.

Where, to avoid frequent grade intersections with other streets and highways the interregional highway is depressed, the [illegible] of the excavation [illegible] not steeper than [illegible] foot [illegible] 2 feet [illegible]. All excavation slopes shall be rounded at the top and bottom to merge with adjacent ground slopes by curves of natural appearance. Where lateral space for a slope of 1 foot measured vertically to 2 feet measured [illegible] retaining walls shall [illegible] the face of such walls shall [illegible] at least 10 feet and in no case less than 8 feet from the edge of [illegible] of the through pavement of the interregional highway, and at least 4 feet from any adjacent lanes or ramps.

Service streets and barrier strips.—Wherever necessary for the service of property, local service streets or ways shall be provided at each side of urban sections of the interregional system [illegible] to facilitate access from [illegible] to the interregional highway. Such streets generally shall be designed as one-way streets, and shall be not less than 24 feet wide.

Service streets or ways shall be separated from the slopes or border areas of the interregional highway by means of nonmountable curbs, and the distance from the face of such curb to the edge of the pavement of the interregional highway shall preferably be not less than 15 feet and in no case less than 10 feet.

Alinement.—Alinement of urban sections of the system shall be of as high a standard as feasible, and the speed assumed for design purposes for a section of road shall be as high as practicable, consistent with the topography, proximity of urban improvements, and expected traffic volume. Under [illegible] the assumption of a design speed higher than 50 miles per hour will usually be impracticable. The design speeds assumed for adjacent sections of the highway shall not differ widely.

Horizontal curvature.—Horizontal curvature on urban sections of the system shall be [illegible] the lowest practicable degree, and at no point sharper than hereinbefore recommended for rural sections of the same assumed design speed.

Transition curvature.—All horizontal circular curves on urban sections of the system sharper than 2° shall be approached by transition curves of a length consistent with the design speed and sufficient to permit the attainment of full superelevation within the length of the transition.

Superelevation of curves.—On urban sections of the system all curves sharper than [illegible]° shall be superelevated as hereinbefore recommended for rural sections, except that maximum superelevation shall be 0.10 foot per foot.

Sight distance.—Sight distance on urban sections of the system shall be at least as great as hereinbefore recommended for rural sections of the same design speed.

Vertical curvature.—Vertical curvature on urban sections of the system shall be as hereinbefore recommended for rural sections.

Number and width of traffic lanes and median strips.—All urban sections of the system expected to carry an average daily traffic of 20,000 or more vehicles shall be designed to provide, when it becomes necessary to do so, three lanes for traffic moving in each direction, each lane to have a width of 12 feet; and the lanes for traffic moving in opposite directions shall be separated by a raised median strip at least 4 feet wide.

Urban sections of the system expected to carry an average daily traffic of less than 20,000 vehicles shall be designed to provide at least 2 lanes for traffic moving in each direction, each lane to have a width of 12 feet, and the lanes for traffic moving in opposite directions shall be separated by a raised median strip at least 4 feet wide.

Transitions of median strip width.—Where narrowing or widening of the median strip is necessary, essential pavement alinement changes shall be accomplished over lengths sufficient to avoid hazard in vehicular operation at the design speed assumed, and to avoid the appearance of distorted or forced alinement.

Shoulders, curbs, and emergency standing areas.—Shoulders 10 feet wide and contrasting in texture and preferably in color with the adjoining pavement shall be constructed on urban sections of the system, or in lieu thereof there shall be constructed, throughout the length of such sections and adjoining the outer edges thereof, mountable curbs, outside and flush with the top of which, there shall be

provided, if financially feasible, an area not less than 10 feet wide, which shall be reserved for the temporary accommodation of disabled or other stationary vehicles.

Drainage.—For the removal of drainage from the pavements, median strips, shoulders, or standing areas, and adjacent slopes of urban sections of the system, an underground drainage system shall be constructed, entrance to which shall be provided at suitable intervals and in appropriate places by means of drop inlets of adequate design and capacity, in such manner as to avoid all possible hazard to traffic and reduction of the traffic capacity of the pavements.

Gradient.—The gradient of urban sections of the system shall preferably be not steeper than 3 percent and shall in no case exceed 5 percent. In general extremely long grades should be less steep and very short grades may be steeper than the limits recommended above. Grades to be traveled only in the downward direction on one-way roads may be steeper than the limits recommended above.

Width of right-of-way.—The right-of-way to be acquired for urban sections of the interregional system shall be at least sufficient to permit the construction of pavements, median strips, areas for deceleration, acceleration, and maneuvering, standing areas, side slopes, [illegible] these facilities as may be required at any point, all constructed in accordance with the foregoing recommendations. The required right-of-way shall be acquired in its entirety by outright purchase or condemnation in accordance with the need for the planned ultimate development of the highway.

Foundations and bases, surfaces, and pavements.—All road foundations and bases and all road surfaces and pavements on urban sections of the system shall conform to the basic standards hereinbefore recommended for foundations, bases, surfaces, and pavements on rural sections of the system.

II. Bridges and culverts.

Definitions.—All structures shall be classed as long bridges, short bridges, or culverts according to the definitions recommended for rural sections of the system.

Alinement of bridges.—All bridges, wherever feasible, shall be so located as to fit the over-all alinement and gradient of the highway and shall be subordinated thereto. Where structural or architectural requirements make it desirable to adjust the alinement and gradient of the highway the changes shall be such that the highway will meet all the basic standards for urban sections of the system recommended hereinunder "I. Roads."

Width of bridges.—The width between vehicular curbs on all bridges built on tangents of urban sections of the system shall be at least 4 feet greater than the width of the pavement of the approach highway, and the lateral distances between the edges of the pavement of the approach highway and the faces of the vehicular curbs shall be at least 2 feet. Where the approach pavements have curbs adjoining the outer lanes thereof, curbs on the approaches and on the bridge shall be continuous.

On all bridges the lateral distance from the face of the curb to the face of the bridge rail or any structural member shall be at least 18 inches and as much more as is necessary for walk space. Where curbs on a bridge are continuous with curbs adjoining the outer lanes of the approach pavement the lateral distance from the outer edge of the approach pavement to the face of the bridge rail or any structural member of the bridge shall be 3 feet 6 inches.

On short bridges over streams, railways, and minor intersecting roads and streets the lateral distance from the edge of the pavement of any approach highway to the face of the bridge rail or any structural member of the bridge shall be not less than the width of shoulder or standing area of the approach highway.

On sections of the system improved with divided highways one bridge to accommodate both roadways and the median strip or ways separate bridges each to accommodate one roadway may be used. On short bridges the roadways shall be accommodated without division from the median strip, and on long bridges the two roadways shall be so accommodated as far as [illegible].

Where the median strip is used as width for the bridge it shall be [illegible] and over such gutters as may be necessary for the drainage of the roadways and pavements operated at the usual [illegible]. Where the median strip is separated or protected [illegible] the two roadways shall be separated on the bridge by a raised [illegible] strip not less than 4 feet wide.

Auxiliary lanes on bridges.—Where auxiliary lanes or ledges for other purposes project beyond the bridge [illegible] that they provide the equivalent of through traffic lanes on the approach highway shall be provided on the bridge, the approach highway [illegible] the use of any such auxiliary lane by vehicles [illegible] the bridge [illegible].

Bridge approaches.—On all bridges on [illegible] approaches shall be constructed for the full [illegible] and shall [illegible] as nearly as practicable for the full width of the bridge, including [illegible] the length of the approach highway in which the distance [illegible] the height of the bridge is measured.

Clear height of bridges.—The clear height of all bridges over the [illegible] width between curbs shall be not less than 14 feet.

Openings under bridges.—All bridges over railways and public streets, roads, or highways shall provide a clear vertical and horizontal [illegible] between abutments or piers as hereinbefore recommended for bridges on rural sections of the system.

Pavements on bridges.—All bridge pavements shall be constructed as hereinbefore recommended for bridges on rural sections of the system.

Structural design of bridges.—All bridges shall be structurally designed as hereinbefore recommended for bridges on rural sections of the system.

Width of culverts.—The over-all clear width of all culverts shall be equal to the sum of the widths of the surfaces or pavements, median strip and shoulders or [illegible] standing areas [illegible] the approach highway with which they are [illegible].

On divided highways the two roadways shall be separated over culverts by a median strip of the width prevailing on the highway approaching the culvert, and the [illegible] covers shall be surmounted with [illegible] and an earth or [illegible] shoulders or safety standing areas, and all earth or [illegible] slopes shall be carried over the culvert [illegible] design with the cross section of the approach highway.

In all other cases the entire clear width shall be paved; and, between lines joining the edges of the pavements on the approach highways at the culvert, the character of such paved areas shall be [illegible] with that of the pavement on the approach highway. All portions of the pavement outside of such lines shall approximate the color of the shoulders or emergency standing areas.

Structural design of culverts. All culverts shall be structurally designed as hereinbefore recommended for culverts on rural sections of the system.

III. Underpasses.

All underpasses on urban sections of the system shall be designed to the same standards as hereinbefore recommended for rural sections of the system, except that structures designed to carry crossing highways shall in no case be designed for less than the standard H20 loading specified by the American Association of State Highway Officials, as described in appendix VI and the bridge width shall be sufficient to accommodate necessary sidewalks outside of the vehicular curbs. References to shoulders in the standards recommended for rural sections shall be interpreted as applying to either shoulders or emergency standing areas on urban sections of the system.

IV. Access facilities.

Urban sections of the system shall be designed for provision of access to the interregional highway only at the more important intersecting roads or streets.

Direct interchanges.—Where, at points of access on urban sections of the system a large volume of interchanging traffic is expected, provision for direct interchange, by both left- and right-turning movements, shall be made, wherever feasible, in the same manner as recommended for rural sections of the system.

Arrangement of ramps at right-turning connections.—Where, on urban sections of the system, access is to be provided from grade-separated intersecting roads or streets, and the provision of direct connections for left- and right-turning movements is not feasible, ramps or connections between the intersecting roads or streets, providing for exit from and entrance to the interregional highway by right-turning movements only, may be provided in the same manner as hereinbefore recommended for rural sections of the system. Instead of connecting directly with an intersecting road or street, such ramps or connections from urban sections of the system may connect with a parallel service street or way and thence indirectly with the intersecting road or street; and similar connection may be made with a service street or way at any desired point apart from a grade-separated intersecting road or street. (See pl. X.)

All ramps and connections shall provide either within their own length or within such length in combination with a section of the parallel service street or way sufficient storage space for traffic leaving the interregional highway so that such traffic, if temporarily blocked at the intersecting street, will not back up onto the interregional highway.

Alinement of ramps or connections.—All ramps connecting with urban sections of the interregional system shall preferably be designed as one-way roads separated for the whole length of ramp. Where two-way ramps are used, entrances and exits at the interregional highway and, if deemed feasible, at the intersecting highway also shall be designed as one-way roads separated by suitable channelizing islands. Entrances and exits shall be located at sufficient distances from any grade-separating structure to provide sight distances adequate for safety under the conditions of vehicular speed to be anticipated.

All ramps and connections shall be designed to enable vehicles to leave the through traffic lanes of the highway at 0.7 of its design speed except where stop or traffic signals are necessary. The maximum rate of curvature of such roads as may properly not exceed 4° [illegible] under no conditions shall exceed 7°. All curves shall be circular or compound.

Width of pavement, shoulders, and side slopes.—All ramps and connections shall conform to the standards recommended for rural sections of the system.

Added space for turning maneuvers.—Added space for turning maneuvers shall be provided and shall be designed as hereinbefore recommended for rural sections of the system.

Grades.—The [illegible] of ramps shall not exceed 6 per cent, except where topographic conditions make steeper ramps and connections necessary. [illegible] grades of vertical curves and clear-areas of lateral and corner distances to vision shall be such as to provide safe design speeds on ramps and connections and from the terminal sections along the through highway and intersecting road or street consistent with the probable safe rate of vehicular speed.

Bus stops.—Bus stops shall be prohibited on all urban sections of the interregional system. Access connections for bus stops off the interregional highway shall be designed to the same standards as other access connections.

V. Tunnels.

Tunnels on urban sections of the interregional system shall accommodate the same number and width of traffic lanes as are provided on the adjacent highway approaches, and shall conform to all recommendations made for tunnels on rural sections of the system.

VI. Pedestrian and recreational facilities.

On urban sections of the system pedestrian use of road surfaces and pavements shall be prohibited.

Pedestrian use of roadsides or parking areas shall be prohibited wherever practicable. Where walks are provided, they shall be separated from the edge of the pavement for vehicles by a curb and a strip at least 6 feet wide.

Where the shoulder or border areas of the interregional highway are of dimensions sufficient to permit their safe use for pedestrian purposes or for recreational facilities such as bicycle paths and playgrounds for both road users and nearby residents, their use for such purposes shall be encouraged either by the provision of these facilities or the assignment of space for their future development

in accordance with an approved development plan. If so used, adequate steps, ramps, or walks shall be provided to give access to such areas from the adjacent service streets or ways, and, if necessary, barriers such as fences shall be provided to prevent pedestrian encroachment on the pavements for vehicular travel.

Adequate crosswalks for pedestrians shall be provided on all bridges and within all underpasses carrying intersecting streets or highways over or under the interregional highway, and steps or ramps may be provided from such bridges or underpasses to give pedestrian access to median strip or border areas capable of safe recreational or other pedestrian use.

In addition to the pedestrian-crossing facilities provided at intersecting streets or highways, special bridges or underpasses for pedestrians shall be provided at such intervals as may be necessary for the convenient crossing of the pavements of the highway.

Paths for pedestrians shall be equal in surface smoothness and accessibility to the surfaces provided for vehicular travel.

VII. Landscaping.

On all urban sections of the system the landscaping design shall conform, wherever feasible, to the recommendations hereinbefore made for rural sections of the system.

VIII. Signs and pavement markings.

The installation of traffic control signals shall be prohibited on urban sections of the system.

On all urban sections of the system, signs and pavement markings shall be provided as hereinbefore recommended for rural sections of the system, except that speed control signs shall be used only where the maximum safe speed under normal conditions is less than 50 miles per hour, in which case signs warning of the approach, the presence, and the termination of such sections shall be provided in a manner similar to the recommendations made for rural sections of the system. Where State or local traffic regulations govern the maximum speed, such maximum speed limits shall be indicated at appropriate intervals by signs bearing the legend "Speed limit ——."

IX. Lighting.

All urban sections of the interregional system shall be lighted by artificial fixed-source illumination to provide the maximum degree of safety and convenience of movement at night. At all connections illumination shall be provided for such distance and in such degree as may be necessary to provide a safe transition between the normal system lighting on the interregional highway and the normal degree of illumination on the connecting street. Illumination of the interregional highway shall not terminate abruptly at the limits of urban sections but shall be extended in diminishing degree for such distance as may be necessary to insure safe transition from lighted to unlighted sections or to sections on which the illumination is of lower degree.

X. Provision for public utilities.

The erection of electric light, power, and telephone poles and the construction of underground utilities shall be restricted on urban sections of the system as hereinbefore recommended for rural sections of the systems.

Where underground utility lines, which require regular and not infrequent maintenance, repair and replacement, cross urban sections of the system they shall be placed in service tunnels under the pavements to insure continuous and undisturbed operation of traffic on the interregional highway.

APPENDIX VI

Standard Design Loadings for Highway Bridges

As Specified by the American Association of State Highway Officials, 1941

Highway loadings.—The highway live loadings on the roadway of bridges or incidental structures shall consist of standard trucks or of lane loads which are equivalent to truck trains. Two systems of loading are provided, the H loadings and the H-S loadings, the corresponding H-S loadings being greater than the H loadings.

The H loadings are illustrated in figures 1 and 2 of this appendix. They consist of a four-wheel truck or the corresponding lane loading. The H loadings are designated by the letter H followed by a number indicating the gross weight in tons of the standard truck.

The H-S loadings are illustrated in figures 3 and 4 of this appendix. They consist of a tractor-truck with semitrailer or the corresponding lane loading. The H-S loadings are designated by the letter H followed by a number indicating the gross weight in tons of the tractor-truck and the letter S followed by the gross weight in tons of the single axle of the semitrailer. The H-S truck loadings shall be used for loaded lengths greater than 40 feet. The H-S truck loading shall be used for loaded lengths of 40 feet or less.

The H-S loading is optional under these specifications and shall not be construed as a requirement thereof.

Highway loadings shall be of five classes: H20, H15, H10, H20–S16, and H15–S12. Loadings H15 and H10 are 75 and 50 per cent, respectively, of loading H20. Loading H15–S12 is 75 percent of loading H20–S16. If loadings of weights other than those designated are desired, they shall be obtained by proportionately increasing the weights shown for both the standard truck and the corresponding lane loads, maintaining the axle spacing constant. The loads for one classification and lane loads for another classification shall not be used in combination.

Traffic lanes.—The lane loadings or standard trucks shall be assumed to occupy traffic lanes, each having a width of 10 feet corresponding to the standard truck clearance width. Within the corresponding width of the roadway, the traffic lanes shall be assumed to occupy any position which will produce the maximum stress, but which will not involve overlapping of adjacent lanes, nor place the center of the lane less than 5 feet from the roadway face of the curb.

Standard trucks and lane loads.—The wheel spacing, weight distribution, and clearance of the standard H and H-S trucks shall be as shown in figures 1 and 3 and corresponding lane loads shall be as shown in figures 2 and 4.

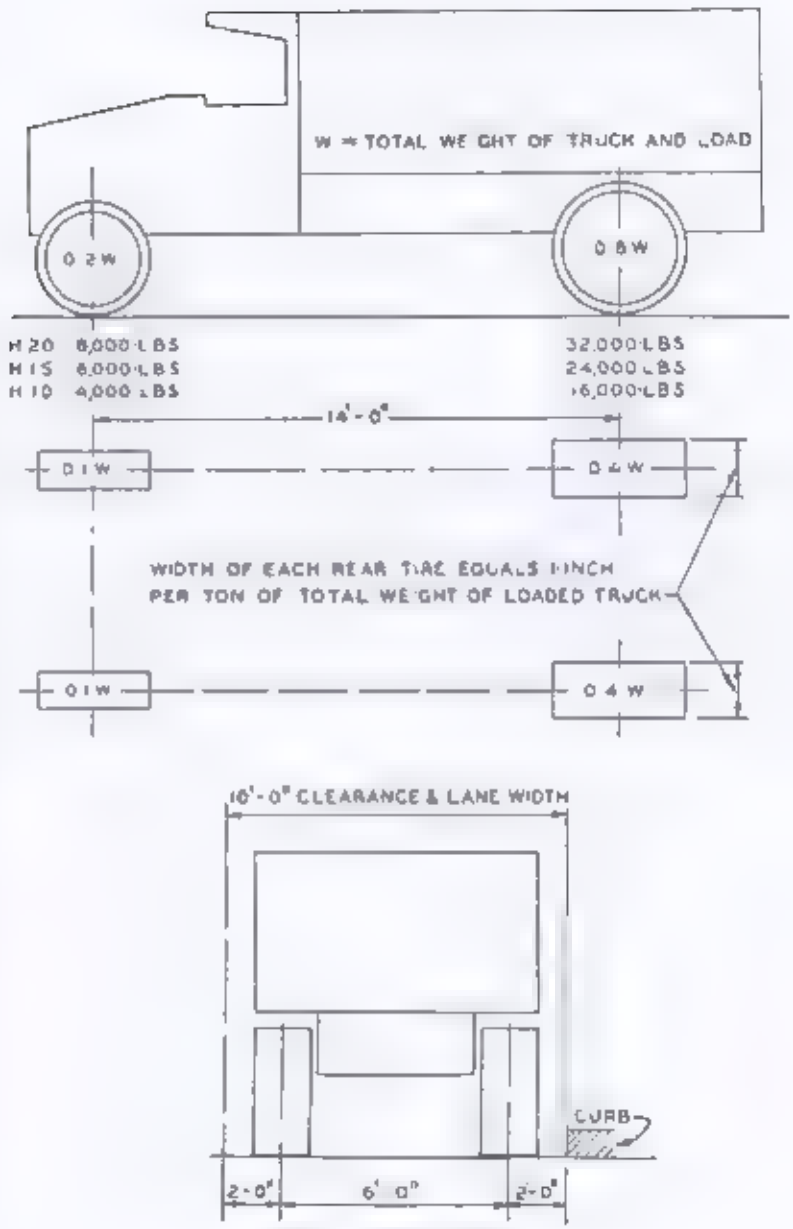
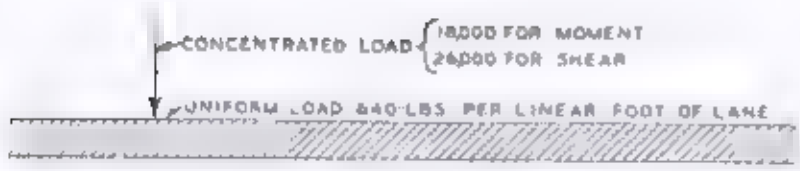
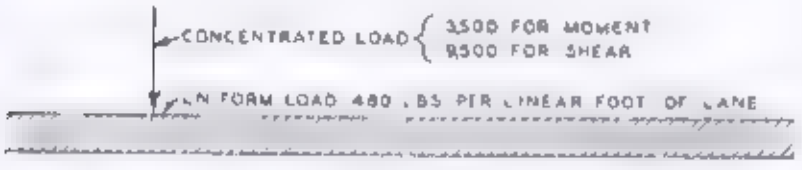


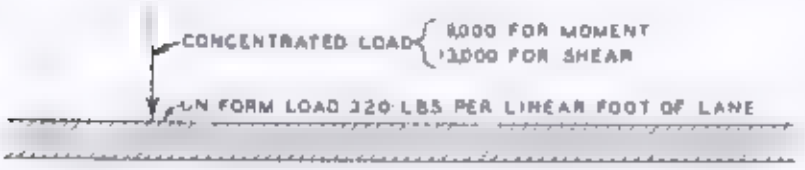
FIGURE 1.—Standard H trucks.



H 20 LOAD NG

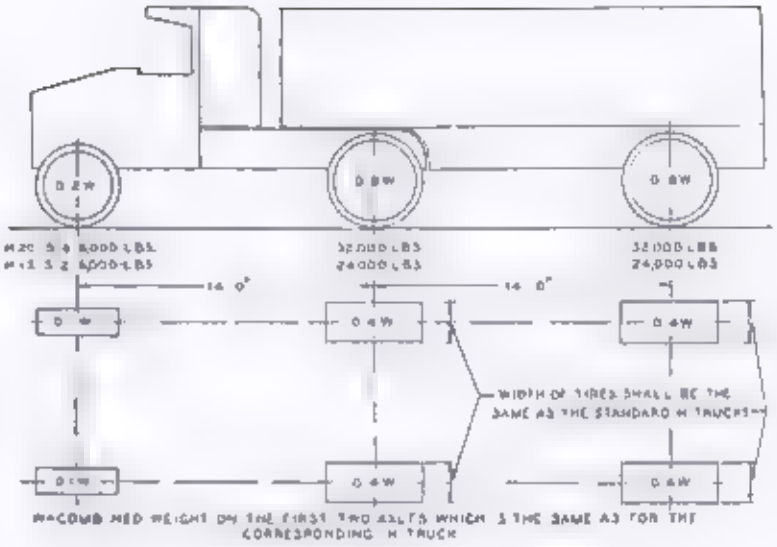


H 15 LOADING



H 10 LOADING

Figures 2.—H loadings



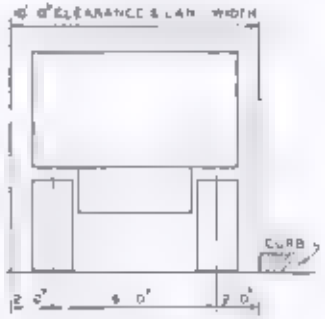


Figure 3. Standard H-S trucks.

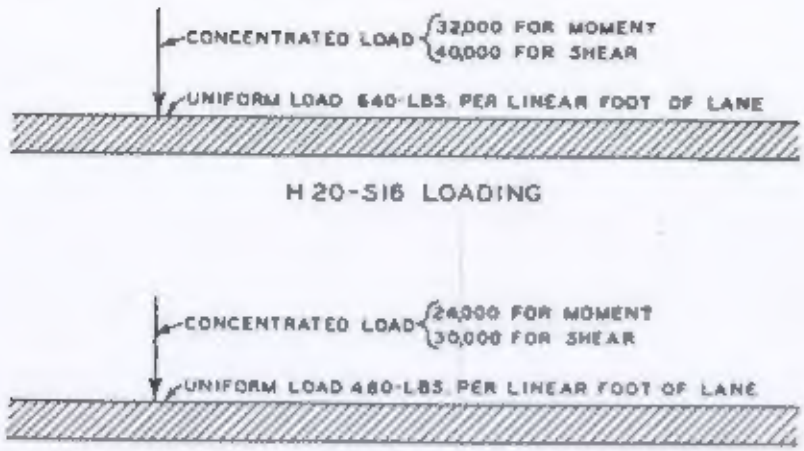


FIGURE 4.—H-S lane loadings.

Each lane loading shall consist of a uniform load per linear foot of traffic lane combined with a single concentrated load so placed on the span as to produce maximum stress. The concentrated load shall be considered as uniformly distributed across the lane on a line normal to the center line of the lane. For the computation of moments and shears, different concentrated loads shall be used as indicated in figures 2 and 4. The lighter concentrated loads shall be used when the stresses are primarily bending stresses and the heavier concentrated loads shall be used when the stresses are primarily shearing stresses.

Application of loadings.—In computing stresses, each 10-foot traffic lane loading or a single standard truck per lane shall be considered as a unit. The number and position of loaded lanes, and the type of loading—truck loading or lane loading—shall be such as to produce a maximum stress subject to reductions specified under the head "Reduction in load intensity." Fractional lane widths are not to be considered. The H-S lane loading shall be used for loaded lengths over 40 feet, and the H-S truck loading for loaded lengths of 40 feet or less. For H loading, either the lane loading or the truck loading shall be used, depending upon which gives the larger stress.

On any series of continuous spans, discontinuous lengths of lane loading shall be used where necessary for maximum stress, but only one concentrated load shall be used.

Reduction in load intensity.—Where maximum stresses are produced in any member by loading any number of traffic lanes simultaneously, the following percentages of the resultant live load stresses shall be used in view of improbable coincident maximum loading:

	Percent
1 or 2 lanes	100
3 lanes	90
4 lanes or more	75

The position and number of loaded lanes used shall be such as to produce maximum stresses in all cases.

The reduction in intensity of floor-beam loads shall be determined

APPENDIX VII

NATIONAL INCOME, CONSTRUCTION EXPENDITURES, AND HIGHWAY EMPLOYMENT

TABLE 1.—*National income, construction, maintenance and work relief returns*

(Billions of dollars)

Year	National income	Construction										Maintenance						Federal work relief				Construction, maintenance, and work relief			
		Total	Private, including public utility	Public					Non-Federal public				Total	Private, including public utility	Public			Total	Highway	Other	Grand total	Private, including public utility	Public		
				Total	Highway	Federal public																			
						Total	Highway	Other	Total	Highway	Other														Total	Highway	Other
1919	61.3	4.9	3.9	1.0	0.5	0.1	0.1	0.4	0.9	0.5	0.4		0.4	0.3	0.1	0.1	0.1					5.3	4.2	1.1	0.6	0.5
1920	69.6	5.4	4.3	1.1	0.6	0.1	0.1	0.4	1.0	0.5	0.5		0.4	0.3	0.1	0.1	0.1					5.8	4.6	1.2	0.7	0.5
1921	59.4	4.6	3.6	1.0	0.5	0.1	0.1	0.4	0.9	0.5	0.4		0.4	0.3	0.1	0.1	0.1					5.0	3.9	1.1	0.6	0.5
1922	59.1	4.6	3.6	1.0	0.5	0.1	0.1	0.4	0.9	0.5	0.4		0.4	0.3	0.1	0.1	0.1					5.0	3.9	1.1	0.6	0.5
1923	68.3	5.3	4.2	1.1	0.6	0.1	0.1	0.4	1.0	0.5	0.5		0.4	0.3	0.1	0.1	0.1					5.7	4.5	1.2	0.7	0.5
1924	69.6	5.4	4.3	1.1	0.6	0.1	0.1	0.4	1.0	0.5	0.5		0.4	0.3	0.1	0.1	0.1					5.8	4.6	1.2	0.7	0.5
1925	73.0	5.7	4.5	1.2	0.7	0.1	0.1	0.5	1.1	0.6	0.5		0.4	0.3	0.1	0.1	0.1					6.1	4.8	1.3	0.8	0.5
1926	76.3	6.0	4.7	1.3	0.8	0.1	0.1	0.5	1.2	0.6	0.6		0.4	0.3	0.1	0.1	0.1					6.4	5.0	1.4	0.9	0.5
1927	76.8	6.0	4.7	1.3	0.8	0.1	0.1	0.5	1.2	0.6	0.6		0.4	0.3	0.1	0.1	0.1					6.4	5.0	1.4	0.9	0.5
1928	78.3	6.1	4.8	1.3	0.8	0.1	0.1	0.5	1.2	0.6	0.6		0.4	0.3	0.1	0.1	0.1					6.5	5.1	1.4	0.9	0.5
1929	82.5	6.4	5.0	1.4	0.9	0.1	0.1	0.5	1.3	0.7	0.6		0.4	0.3	0.1	0.1	0.1					6.8	5.3	1.5	1.0	0.5
1930	74.8	5.8	4.5	1.3	0.8	0.1	0.1	0.5	1.2	0.6	0.6		0.4	0.3	0.1	0.1	0.1					6.2	4.8	1.4	0.9	0.5
1931	58.3	4.5	3.5	1.0	0.5	0.1	0.1	0.4	0.9	0.5	0.4		0.4	0.3	0.1	0.1	0.1					4.9	3.8	1.1	0.6	0.5
1932	42.1	3.3	2.5	0.8	0.4	0.1	0.1	0.3	0.7	0.4	0.3		0.4	0.3	0.1	0.1	0.1					3.7	2.8	0.9	0.5	0.4
1933	40.2	3.1	2.4	0.7	0.4	0.1	0.1	0.3	0.6	0.3	0.3		0.4	0.3	0.1	0.1	0.1					3.5	2.7	0.8	0.4	0.4
1934	47.2	3.7	2.8	0.9	0.5	0.1	0.1	0.4	0.8	0.4	0.4		0.4	0.3	0.1	0.1	0.1	0.1	0.1		0.1	4.1	3.1	1.0	0.6	0.4
1935	51.4	4.0	3.0	1.0	0.5	0.1	0.1	0.4	0.9	0.5	0.4		0.4	0.3	0.1	0.1	0.1	0.2	0.2		0.2	4.5	3.4	1.1	0.7	0.4
1936	58.3	4.5	3.4	1.1	0.6	0.1	0.1	0.5	1.0	0.5	0.5		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	5.0	3.8	1.2	0.8	0.4
1937	64.6	5.0	3.8	1.2	0.7	0.1	0.1	0.5	1.1	0.6	0.5		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	5.5	4.2	1.3	0.9	0.4
1938	60.4	4.7	3.5	1.2	0.7	0.1	0.1	0.5	1.1	0.6	0.5		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	5.1	3.9	1.2	0.8	0.4
1939	67.4	5.2	3.9	1.3	0.8	0.1	0.1	0.5	1.2	0.6	0.6		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	5.7	4.3	1.4	0.9	0.5
1940	74.3	5.7	4.3	1.4	0.9	0.1	0.1	0.5	1.3	0.7	0.6		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	6.2	4.7	1.5	1.0	0.5
1941	90.5	6.9	5.2	1.7	1.1	0.1	0.1	0.6	1.6	0.9	0.7		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	7.4	5.6	1.8	1.3	0.5
1942	103.1	7.9	5.9	2.0	1.3	0.1	0.1	0.6	1.9	1.1	0.8		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	8.4	6.3	2.1	1.5	0.6
1943	120.1	9.2	6.9	2.3	1.5	0.1	0.1	0.7	2.2	1.3	0.9		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	9.7	7.3	2.4	1.7	0.7
1944	132.7	10.2	7.6	2.6	1.7	0.1	0.1	0.8	2.5	1.5	1.0		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	10.7	8.1	2.6	1.9	0.7
1945	132.1	10.2	7.6	2.6	1.7	0.1	0.1	0.8	2.5	1.5	1.0		0.4	0.3	0.1	0.1	0.1	0.3	0.3		0.3	10.7	8.1	2.6	1.9	0.7

TABLE 1.—*National income, construction, maintenance and work relief volume*—Continued

National income	Construction										Maintenance				Federal work relief			Construction, maintenance, and work relief				
	Total	Private, including public utility	Public			Federal public			Non-Federal public				Public						Public		
			Total	Highway	Other	Total	Highway	Other	Total	Highway	Other	Total	Private, including public utility	Total	Highway	Other	Total	Highway	Other	Grand total	Private, including public utility	Total	Highway	Other
1929	5,853	4,332	1,521	946	575	1,845	105	1,740	976	111	865	3,119	2,304	815	685	130	935	531	404	10,914	6,585	4,329	2,110	2,219
1930	11,047	5,201	5,846	1,013	4,833	4,497	150	4,347	1,448	833	615	4,401	3,604	797	645	152	730	354	376	17,316	7,877	9,439	2,036	7,403
1931	15,600	2,877	12,723	667	12,056	9,736	342	9,394	555	305	250	4,436	4,033	403	253	150	549	133	189	17,286	5,268	12,018	1,466	10,552
1932	4,923	1,716	3,207	1,492	1,715	2,426	2	2,424	3,496	1,205	1,291	3,559	3,423	136	666	470	----	----	----	31,983	24,923	6,059	1,876	4,183
1933	6,764	2,748	4,016	1,719	2,297	1,909	205	1,704	4,855	2,137	2,718	4,713	3,461	1,252	1,252	0	----	----	----	33,115	24,691	8,424	3,917	4,507
1934	7,661	3,828	3,833	1,799	2,034	715	239	476	6,063	3,400	2,663	5,518	3,973	1,545	1,176	369	673	313	360	48,673	39,347	10,226	5,805	4,421
1935	9,209	4,720	4,489	2,326	2,163	805	304	501	6,126	4,303	1,823	6,660	4,960	1,700	1,253	447	414	357	57	52,926	39,913	13,013	7,813	5,200
1936	11,116	5,758	5,358	2,759	2,599	1,168	869	299	5,647	2,987	2,660	8,140	5,457	2,683	1,867	816	402	183	219	54,771	40,028	14,743	7,313	7,430
1937	13,129	8,009	5,120	2,735	2,385	1,901	1,311	590	2,662	2,184	478	9,456	6,129	3,327	2,711	616	396	135	261	58,463	39,744	18,719	7,777	10,942
1938	11,467	7,604	3,863	1,165	2,698	4,322	1,133	3,189	4,261	2,830	1,431	12,660	10,646	2,014	1,444	570	4,227	3,193	1,034	57,705	35,798	21,907	12,423	9,484
1939	15,960	21,507	5,909	3,919	17,589	17,120	676	16,444	1,839	1,309	530	13,660	9,524	4,136	3,130	1,006	4,224	3,710	1,514	65,463	39,741	25,722	13,523	12,199
1940	15,265	64,530	10,429	23,400	41,100	23,494	21,343	2,151	11,980	7,921	4,059	30,330	24,136	7,644	6,401	1,443	5,173	4,199	974	110,820	59,399	51,421	31,620	19,801
1941	25,307	125,307	25,307	64,530	41,100	28,494	21,343	7,151	30,956	20,964	9,992	32,979	24,569	8,410	6,994	1,416	5,173	4,199	974	267,447	178,275	89,172	58,979	30,193
Total man-months	838,126	70,997	15,265	64,530	41,100	23,494	21,343	2,151	30,956	20,964	9,992	32,979	24,569	8,410	6,994	1,416	5,173	4,199	974	267,447	178,275	89,172	58,979	30,193
	1,616,280	180,056	125,307	64,530	41,100	28,494	21,343	7,151	30,956	20,964	9,992	32,979	24,569	8,410	6,994	1,416	5,173	4,199	974	267,447	178,275	89,172	58,979	30,193

TABLE 2.—*Direct Federal and State highway employment, by months, from 1931 to 1940, inclusive*

Year and month	Number of man-months of direct employment—					
	On Federal and Federal-aid construction	On independent State construction	On all Federal and State construction	On State maintenance	On all construction and maintenance
1931					
January	18,492	62,772	82,264	34,299	116,563
February	37,993	89,947	127,940	50,196	178,136
March	54,849	114,852	169,701	75,334	245,035
April	62,661	124,715	187,376	90,792	278,168
May	84,511	126,470	210,981	94,412	305,393
June	104,811	109,873	214,684	97,892	312,576
July	104,704	104,256	208,960	97,940	306,900
August	111,428	113,792	225,220	97,913	323,133
September	116,100	122,604	238,704	97,930	336,634
October	110,732	122,889	233,621	97,913	331,534
November	102,466	105,109	207,575	97,930	305,505
December	85,991	74,340	160,331	97,930	258,261
Total man-months	1,193,268	1,370,819	2,564,087	1,078,481	3,642,568
1932					
January	82,018	55,660	137,678	97,930	235,608
February	56,673	52,447	109,120	97,930	207,050
March	63,898	56,696	120,594	97,930	218,524
April	70,634	70,845	141,479	97,930	239,409
May	77,772	84,711	162,483	97,930	260,413
June	84,946	84,946	169,892	97,930	267,822
July	85,946	85,946	171,892	97,930	269,822
August	85,946	85,946	171,892	97,930	269,822
September	85,946	85,946	171,892	97,930	269,822
October	85,946	85,946	171,892	97,930	269,822
November	85,946	85,946	171,892	97,930	269,822
December	85,946	85,946	171,892	97,930	269,822
Total man-months	899,673	868,312	1,768,985	1,175,160	2,944,145
1933					
January	74,458	50,000	124,458	97,930	222,388
February	74,458	50,000	124,458	97,930	222,388
March	98,944	56,056	155,000	97,930	252,930
April	122,959	47,041	170,000	97,930	267,930
May	122,959	47,041	170,000	97,930	267,930
June	122,959	47,041	170,000	97,930	267,930
July	122,959	47,041	170,000	97,930	267,930
August	122,959	47,041	170,000	97,930	267,930
September	122,959	47,041	170,000	97,930	267,930
October	122,959	47,041	170,000	97,930	267,930
November	122,959	47,041	170,000	97,930	267,930
December	122,959	47,041	170,000	97,930	267,930
Total man-months	1,353,477	628,885	1,982,362	1,175,160	3,157,522
1934					
January	104,154	35,949	140,103	97,930	238,033
February	136,514	22,311	158,825	97,930	256,755
March	164,033	18,836	182,869	97,930	280,799
April	146,033	34,510	180,543	97,930	278,473
May	137,657	37,161	174,818	97,930	272,748
June	137,657	37,161	174,818	97,930	272,748
July	137,657	37,161	174,818	97,930	272,748
August	137,657	37,161	174,818	97,930	272,748
September	137,657	37,161	174,818	97,930	272,748
October	137,657	37,161	174,818	97,930	272,748
November	137,657	37,161	174,818	97,930	272,748
December	137,657	37,161	174,818	97,930	272,748
Total man-months	1,683,427	465,825	2,149,252	1,175,160	3,324,412
1935					
January	137,657	37,161	174,818	97,930	272,748
February	137,657	37,161	174,818	97,930	272,748
March	137,657	37,161	174,818	97,930	272,748
April	137,657	37,161	174,818	97,930	272,748
May	137,657	37,161	174,818	97,930	272,748
June	137,657	37,161	174,818	97,930	272,748
July	137,657	37,161	174,818	97,930	272,748
August	137,657	37,161	174,818	97,930	272,748
September	137,657	37,161	174,818	97,930	272,748
October	137,657	37,161	174,818	97,930	272,748
November	137,657	37,161	174,818	97,930	272,748
December	137,657	37,161	174,818	97,930	272,748
Total man-months	1,651,884	445,932	2,097,816	1,175,160	3,272,976
1936					
January	137,657	37,161	174,818	97,930	272,748
February	137,657	37,161	174,818	97,930	272,748
March	137,657	37,161	174,818	97,930	272,748
April	137,657	37,161	174,818	97,930	272,748
May	137,657	37,161	174,818	97,930	272,748
June	137,657	37,161	174,818	97,930	272,748
July	137,657	37,161	174,818	97,930	272,748
August	137,657	37,161	174,818	97,930	272,748
September	137,657	37,161	174,818	97,930	272,748
October	137,657	37,161	174,818	97,930	272,748
November	137,657	37,161	174,818	97,930	272,748
December	137,657	37,161	174,818	97,930	272,748
Total man-months	1,651,884	445,932	2,097,816	1,175,160	3,272,976
1937					
January	137,657	37,161	174,818	97,930	272,748
February	137,657	37,161	174,818	97,930	272,748
March	137,657	37,161	174,818	97,930	272,748
April	137,657	37,161	174,818	97,930	272,748
May	137,657	37,161	174,818	97,930	272,748
June	137,657	37,161	174,818	97,930	272,748
July	137,657	37,161	174,818	97,930	272,748
August	137,657	37,161	174,818	97,930	272,748
September	137,657	37,161	174,818	97,930	272,748
October	137,657	37,161	174,818	97,930	272,748
November	137,657	37,161	174,818	97,930	272,748
December	137,657	37,161	174,818	97,930	272,748
Total man-months	1,651,884	445,932	2,097,816	1,175,160	3,272,976
1938					
January	137,657	37,161	174,818	97,930	272,748
February	137,657	37,161	174,818	97,930	272,748
March	137,657	37,161	174,818	97,930	272,748
April	137,657	37,161	174,818	97,930	272,748
May	137,657	37,161	174,818	97,930	272,748
June	137,657	37,161	174,818	97,930	272,748
July	137,657	37,161	174,818	97,930	272,748
August	137,657	37,161	174,818	97,930	272,748
September	137,657	37,161	174,818	97,930	272,748
October	137,657	37,161	174,818	97,930	272,748
November	137,657	37,161	174,818	97,930	272,748
December	137,657	37,161	174,818	97,930	272,748
Total man-months	1,651,884	445,932	2,097,816	1,175,160	3,272,976
1939					
January	137,657	37,161	174,818	97,930	272,748
February	137,657	37,161	174,818	97,930	272,748
March	137,657	37,161	174,818	97,930	272,748
April	137,657	37,161	174,818	97,930	272,748
May	137,657	37,161	174,818	97,930	272,748
June	137,657	37,161	174,818	97,930	272,748
July	137,657	37,161	174,818	97,930	272,748
August	137,657	37,161	174,818	97,930	272,748
September	137,657	37,161	174,818	97,930	272,748
October	137,657	37,161	174,818	97,930	272,748
November	137,657	37,161	174,818	97,930	272,748
December	137,657	37,161	174,818	97,930	272,748
Total man-months	1,651,884	445,932	2,097,816	1,175,160	3,272,976
1940					
January	137,657	37,161	174,818	97,930	272,748
February	137,657	37,161	174,818	97,930	272,748
March	137,657	37,161	174,818	97,930	272,748
April	137,657	37,161	174,818	97,930	272,748
May	137,657	37,161	174,818	97,930	272,748
June	137,657	37,161	174,818	97,930	272,748
July	137,657	37,161	174,818	97,930	272,748
August	137,657	37,161	174,818	97,930	272,748
September	137,657	37,161	174,818	97,930	272,748
October	137,657	37,161	174,818	97,930	272,748
November	137,657	37,161	174,818	97,930	272,748
December	137,657	37,161	174,818	97,930	272,748
Total man-months	1,651,884	445,932	2,097,816	1,175,160	3,272,976
Total man-months	6,998,673	3,157,522	10,156,195	6,054,852	16,211,047

TABLE 2.—*Direct Federal and State highway employment, by months, from 1931 to 1942, inclusive*—Continued

Year and month	Number of man-months of direct employment—				
	On Federal and Federal-aid construction	On independent State construction	On all Federal and State construction	On State maintenance	On all construction and maintenance
1935					
January	98,594	23,537	120,131	130,253	250,384
February	81,257	17,940	99,197	122,209	221,406
March	90,999	18,391	109,390	108,149	217,539
April	123,083	24,193	147,276	135,454	282,730
May	167,635	27,924	195,559	136,541	331,000
June	193,287	30,823	224,110	138,263	362,373
July	201,041	35,836	236,877	140,573	377,450
August	178,756	40,170	218,926	163,980	382,906
September	143,453	40,456	183,909	126,187	310,096
October	143,660	40,350	176,950	147,324	324,274
November	118,894	32,467	151,361	139,136	290,497
December	106,493	32,046	138,539	123,580	262,119
Total man-months	1,678,014	358,148	1,992,132	1,695,783	3,619,925
1936					
January	92,731	14,358	97,089	105,705	202,804
February	70,415	10,256	80,674	119,777	200,451
March	86,050	8,350	94,200	153,366	247,566
April	132,836	11,339	144,175	143,366	287,476
May	193,260	16,068	209,328	164,856	374,191
June	237,330	20,773	258,103	165,163	423,466
July	249,271	21,744	271,015	166,956	437,971
August	247,541	26,810	274,402	153,480	427,882
September	227,010	34,459	261,379	151,772	414,147
October	206,113	34,116	240,349	149,717	392,066
November	172,205	27,668	200,393	153,686	354,071
December	128,316	23,394	149,768	138,540	288,308
Total man-months	2,034,382	247,978	2,282,305	1,749,837	4,031,892
1937					
January	70,929	15,422	82,431	117,578	200,027
February	57,544	11,706	69,250	120,795	190,234
March	69,940	11,801	81,708	119,046	200,754
April	88,361	13,044	101,325	124,761	226,256
May	122,655	17,201	139,806	150,167	289,043
June	145,875	18,382	164,757	148,362	313,149
July	159,489	25,140	184,629	149,907	334,536
August	163,331	28,379	191,710	159,143	351,853
September	152,784	23,632	176,416	167,029	343,445
October	149,617	27,389	177,007	169,045	346,052
November	124,364	23,497	147,861	167,132	314,993
December	85,364	23,825	109,189	146,340	255,529
Total man-months	1,386,000	249,664	1,635,654	1,738,323	3,373,977
1938					
January	54,899	14,364	70,263	126,685	196,858
February	42,713	12,252	54,965	115,710	177,675
March	51,229	14,379	65,608	116,812	182,420
April	67,529	14,073	81,602	132,000	213,602
May	93,179	17,674	115,853	136,563	252,416
June	114,573	19,875	134,448	159,992	294,440
July	125,036	20,564	145,600	165,906	311,506
August	120,960	26,649	147,609	170,161	317,770
September	132,300	32,054	164,444	173,194	337,638
October	129,270	35,426	164,696	185,394	350,090
November	110,073	29,435	139,512	203,821	343,333
December	82,238	21,223	103,461	193,139	296,600
Total man-months	1,140,121	265,972	1,405,133	1,871,795	3,276,925

TABLE 2.—*Direct Federal and State highway employment, by months, from 1931 to 1942, inclusive*—Continued

Year and month	Number of man-months of direct employment—				
	On Federal and Federal-aid construction	On independent State construction	On all Federal and State construction	On State maintenance	On all construction and maintenance
1939					
January	57,854	14,254	72,108	128,191	200,199
February	45,804	12,011	58,815	117,264	176,079
March	47,109	11,093	58,202	110,533	168,735
April	63,317	12,477	75,794	108,129	183,923
May	89,109	15,006	104,804	115,119	220,923
June	113,566	20,177	130,743	121,573	252,316
July	118,300	20,045	138,344	126,157	264,502
August	139,202	23,586	142,788	132,161	274,949
September	117,668	25,740	142,408	134,695	277,103
October	104,652	28,242	133,004	128,856	262,760
November	89,228	23,586	112,814	114,417	227,231
December	62,779	19,066	81,845	103,816	185,661
Total man-months	1,029,337	225,303	1,254,732	1,443,051	2,698,833
1940					
January	36,458	16,502	42,960	102,747	145,707
February	37,455	15,612	43,267	126,325	169,592
March	37,792	22,625	60,417	104,309	164,726
April	63,815	32,911	96,726	111,438	208,164
May	93,167	47,345	139,512	124,192	263,044
June	98,670	55,679	154,349	134,051	288,400
July	103,820	61,705	165,525	156,245	321,773
August	108,246	64,183	172,379	137,703	310,083
September	106,268	66,036	172,304	136,021	308,325
October	93,704	67,608	161,252	140,226	301,478
November	70,669	50,646	121,315	128,499	249,814
December	29,970	34,210	74,250	118,239	192,489
Total man-months	854,937	535,602	1,390,559	1,478,955	2,869,514
1941					
January	29,430	26,025	55,455	106,420	161,875
February	25,811	21,883	47,693	99,503	147,196
March	31,166	26,713	58,079	101,835	157,914
April	52,430	34,608	87,038	110,012	197,050
May	71,626	54,214	126,840	118,945	245,785
June	80,436	61,769	142,205	134,896	277,051
July	87,184	65,807	152,991	135,651	288,642
August	91,045	67,699	158,744	138,651	297,395
September	84,259	65,501	149,760	128,615	278,375
October	71,779	63,852	135,622	124,523	260,145
November	57,761	53,994	111,755	108,559	220,314
December	36,267	38,704	75,131	110,312	185,443
Total man-months	719,955	578,978	1,298,933	1,429,301	2,727,984
1942					
January	22,290	26,989	49,113	105,920	155,033
February	21,657	22,195	44,852	101,057	145,909
March	25,061	27,914	52,975	102,023	154,998
April	33,781	38,639	72,420	105,441	177,861
May	42,161	47,922	90,103	107,804	197,907
June	46,187	46,615	89,809	112,009	201,809
July	44,749	49,443	94,191	114,361	208,552
August	43,809	48,213	90,022	117,972	207,994
September	35,852	41,956	80,536	109,676	190,212
October	36,237	41,772	78,011	105,701	183,732
November	25,462	30,488	56,947	100,898	157,845
December	19,712	20,870	40,588	94,109	134,698
Total man-months	400,962	441,161	842,577	1,376,991	2,219,568

TABLE 3.—*Direct Federal and State highway employment, by years, from 1931 to 1942, inclusive*

Years	Number of man-years of direct employment				
	On Federal and Federal-aid construction	On independent State construction	On all Federal and State construction	On State maintenance	On all construction and maintenance
1931	92,321	88,351	180,373	103,893	284,766
1932	74,173	73,610	147,783	143,351	291,134
1933	127,700	50,938	178,638	151,120	329,757
1934	224,155	41,156	265,291	155,899	421,190
1935	125,333	39,956	165,289	136,299	301,588
1936	160,582	31,064	190,196	142,795	332,991
1937	115,583	29,805	145,388	144,698	290,086
1938	95,010	22,054	117,064	156,978	274,042
1939	83,696	19,033	104,729	130,254	234,983
1940	71,306	44,634	115,940	122,349	238,289
1941	59,971	48,248	108,219	119,109	227,328
1942	33,411	36,762	70,173	104,366	174,539
PERIOD TOTALS					
1931–34	519,629	253,925	773,543	553,264	1,326,809
1935–38	515,490	93,479	608,969	582,870	1,191,839
1939–42	264,324	148,677	369,001	498,979	867,979
1931–42	1,299,464	496,081	1,794,465	1,635,122	3,386,587
ANNUAL AVERAGES BY PERIODS					
1931–34	129,908	63,481	193,386	138,316	331,702
1935–38	128,873	23,370	152,243	145,717	297,959
1939–42	66,081	37,169	92,250	124,745	216,995
1931–42	107,117	41,340	149,497	136,260	272,756

TABLE 4.—*Federal and State highway expenditures, by years, 1931 to 1942, inclusive*

Years	Federal construction expenditures	State construction expenditures	Total construction expenditures	State expenditures for maintenance (including maintenance equipment)	Total expenditures for construction and maintenance
	Thousands of dollars	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*	*Thousands of dollars*
1931	242,137	496,815	738,952	182,483	913,435
1932	106,040	445,406	551,446	191,611	743,057
1933	182,943	265,809	448,752	184,075	630,917
1934	316,738	267,540	584,278	157,174	741,452
1935	213,654	203,758	416,413	191,277	607,689
1936	220,555	276,899	497,454	236,205	733,659
1937	262,201	289,778	551,979	238,598	790,577
1938	193,621	329,694	523,315	235,905	759,220
1939	173,139	294,213	467,352	210,131	677,483
1940	168,557	354,228	522,785	215,093	737,878
1941	155,951	362,114	518,065	229,954	747,259
1942	132,398	[1] 256,689	[1] 389,073	[1] 217,328	606,402
PERIOD TOTALS					
1931–34	847,857	1,413,081	2,293,529	715,334	2,908,864
1935–38	1,000,051	1,098,929	2,098,160	801,985	2,900,945
1939–42	609,053	1,267,244	1,897,307	871,506	2,768,833
1931–42	2,507,971	3,801,858	6,309,827	2,479,905	8,788,932
ANNUAL AVERAGES BY PERIODS					
1931–34	211,965	353,270	573,382	178,833	749,714
1935–38	250,013	274,733	524,746	200,496	747,743
1939–42	165,013	316,811	451,529	217,902	669,731
1931–42	208,998	316,821	525,819	206,992	732,811

[1] Preliminary estimate.